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WATER RESOURCE ENGINEERS

TOWN OF HINESBURG, VERMONT

Wastewater Treatment Facility Planning Study

July 2016

DRAFT

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1. EXECUTIVE SUMMARY

The Town operates a 0.250 mgd aerated lagoon wastewater treatment facility that is regulated under Discharge Permit No. 3-1172. In 2009, this facility was upgraded to address age related needs. During the upgrade, new equipment installed for the sewage pumps, lagoon aeration system, and aeration blowers were sized for a future permitted capacity increase to 0.308 mgd.

The current permit limits phosphorus to an annual limit of 608 lbs or monthly average concentration of 0.8 mg/l. A new Lake Champlain Phosphorus TMDL was issued on June 17, 2016. In this TMDL, the wasteload allocation (WLA) for Hinesburg will be reduced to 152.2 lbs based on a concentration of 0.2 mg/l at the permitted flow of 0.250 mgd. The renewal of the Discharge Permit for Hinesburg is expected to follow the issuance of the Tactical Basin Plans which is currently scheduled in 2018. Once the permit is renewed, commencement of the process to upgrade phosphorus treatment facilities will be required when actual phosphorus loads reach 80% of the TMDL WLA limits.

Historical operating data for this facility was reviewed for the prior 3 years (January 2013 through December 2015) to document the current operating conditions.

- Effluent flows were 0.140 mgd or 56% of the permitted capacity.
- Other than the spring of 2014, the effluent total suspended solids are consistently less than 10 mg/l.
- The effluent phosphorus concentration was 0.43 mg/l, and for 2015 the total annual lbs were 108 lbs. It should be noted that this annual discharge isn't consistently achievable, especially as the flows continue to increase with new connections.
- Effluent ammonia concentrations were consistently less than 12 mg/l, but monitoring was only required from June through September.

Information provided by the Town (dated May 26, 2015) on the uncommitted reserve capacity is summarized as follows:

- Total of committed reserve capacity is 17,130 gpd
- Per the allocation ordinance, 20,000 gpd is reserved
- 72,453 gpd is uncommitted

Once the flows approach 80% of the permitted capacity or 200,000 gpd, planning for expansion will be required. The Town should have another 3 to 5 years of capacity available before planning for expansion is required, but this timeline will be impacted by how quickly the new approved residential and commercial customers are connected.

The Town wants to explore the option of increasing the permitted capacity of the existing aerated lagoon facility from 250,000 to 308,000 gpd. This change requires an amendment of the existing Discharge Permit and will be subject to the lower phosphorus limit of 152.2 lbs once the

Discharge Permit is amended. The State has also raised concerns about the impacts of the ammonia levels discharged to the La Platte River. Currently, there is no permit limit for ammonia. Based on discussions with the State, increased ammonia monitoring and a compliance schedule will likely be required in the next permit renewal.

Alternatives were evaluated for expansion of the aerated lagoon to a capacity of 0.308 mgd. The Lemna LemTec biological treatment process would convert a portion of the existing lagoons to a covered two lagoon system followed by a polishing reactor. The EDI IDEAL system would convert a portion of the lagoons to a constant inflow, batch process, similar to a sequential batch reactor system. Upgrade of the lagoons would also require replacement of the original bentonite liner with a new HDPE lagoon liner. At an estimated cost of $3.5 M to upgrade the existing aerated lagoons, both of these systems can achieve lower ammonia limits but not the lower phosphorus limits. Addition of effluent pumping and a phosphorus removal technology suitable for aerated lagoons will be required to comply with the lower phosphorus limit, and based on similar type and size facilities this cost will range from $3.5 to $5.0 M.

Expansion of a treatment facility option to a capacity of 0.450 mgd that can comply with an ammonia limit and lower phosphorus limit was also evaluated. A sequential batch reactor (SBR) process was identified as a similar process that would be suitable for comparison purposes. For ease of construction and to maintain operation of the aerated lagoon, this new facility could be located on Town owned property within the existing lagoons or to the east of the existing lagoons. This new facility would include the following elements; headworks, 2 SBR tanks, flow equalization/effluent pumping, filtration, disinfection, aerated sludge holding and control building. An estimated cost for this new larger facility is $9.0 to $10.0 M, and typical annual operating costs will increase to about $450,000.

The Town will be faced with addressing the following issues regarding the wastewater treatment facility;

- The need for more treatment capacity,
- compliance with the lower phosphorus limit,
- and a future ammonia limit.

The existing aerated lagoon facility has the capability to increase the permitted capacity to 0.308 mgd but isn't sufficient to provide consistent compliance with the lower phosphorus limit, and the upgrade is at a similar cost as the new facility approach. Significant future upgrades will be required, so the Town will need to begin the short-term financial planning for either upgrade of the aerated lagoon facility or construction of a new larger treatment facility on Town owned land. Unfortunately, the schedules for renewal of the Discharge Permit are not yet determined, but a new Discharge Permit should be anticipated in the next 2 to 3 years which will specify the lower phosphorus limit and increased ammonia monitoring.

2. INTRODUCTION AND BACKGROUND

2.1 Purpose

In 2009, the 0.250 mgd aerated lagoon wastewater treatment facility was upgraded to address the age related needs. During the upgrade, new equipment installed for the sewage pumps, lagoon aeration system and blowers was sized for a future capacity increase to 0.308 mgd.

The Town of Hinesburg wants to conduct a planning study to address the following issues related to the lower permit limits for phosphorus and the need for increased treatment capacity:

- The Lake Champlain Total Daily Maximum Load (TMDL) for phosphorus is currently being finalized by EPA and will require future upgrades at the WWTF. EPA has developed waste load allocations (WLA) for all WWTFs that discharge to the Lake Champlain Basin.
    - For Hinesburg, it has been identified that the facility will be required to meet an effluent total phosphorus limit based on an annual lbs loading and calculated for 0.2 mg/l at the permitted flow. The discharge permit for Hinesburg is scheduled to be renewed in 2016, so the Town wants to assess the impacts at current and permitted flow conditions.
    - Analyze the impacts for a lower phosphorus limit of 0.1 mg/l.
- Determine whether an increase in capacity from the permitted flow of 250,000 to 308,000 gpd is possible. If this is possible, determine what the range of costs are, permits required, and timeline.
- Develop and assess an option for expanding the treatment capacity to 450,000 to 500,000 gpd to support the full Village build-out scenario.

2.2 SCOPE

The scope of this study includes the following tasks:

- Review existing information
- Assess WWTF operating data
- Identify new permit issues
- Evaluate expansion and phosphorus removal alternatives
- Prepare report
- Review meetings

3. HISTORICAL OPERATIONS

3.1 Permit Limitations

The current facility operates under Discharge Permit No. 3-1172 with an expiration date of September 30, 2010, and defines the effluent limitations based on the permitted flow of 0.250 mgd. Under Section I.A. of the Discharge Permit, the Town is allowed to discharge from the treatment facility outfall (S/N 001) to the LaPlatte River an effluent whose characteristics do not exceed the values presented in the Permit. A summary of the permitted effluent limitations are provided in Table 3.1.

Table 3.1
Permitted Effluent Limitations

Effluent Characteristics	Annual Limits	Monthly Average	Weekly Average	Maximum Day	Instantaneous Maximum
Flow (Annual Average)	0.250 mgd	---	---	---	---
Ultimate Oxygen Demand[1]	---	---	---	400 lbs/day	
Biochemical Oxygen Demand (BOD_5)	---	30 mg/l 63 lbs/day	45 mg/l 94 lbs/day	50 mg/l	---
Total Suspended Solids (TSS)	---	45 mg/l 94 lbs/day	45 mg/l 94 lbs/day	50 mg/l	---
Total Phosphorus (TP)	608	0.8 mg/l			
Total Residual Chlorine	---	---	---	---	0.1 mg/l
Total Kjeldahl Nitrogen (TKN)				Monitor only	
Ammonia				Monitor only	
Settleable Solids	---	---	---	---	1.0 ml/l
E. Coli	---	---	---	---	77/100 ml
pH	---	Between 6.5 and 8.5 Standard Units			

Notes:

1. Ultimate oxygen demand limitation shall apply from June 1 through September 30.

3.2 Flows

The Discharge Permit limits the average monthly effluent flow to 0.250 mgd. As shown in Figure 3.1, from January 2013 through December 2015, the average monthly effluent flow was 0.14 mgd which is approximately 56% of the permitted average monthly effluent flow. The WWTF saw a maximum effluent flow of .27 mgd in June 2013.

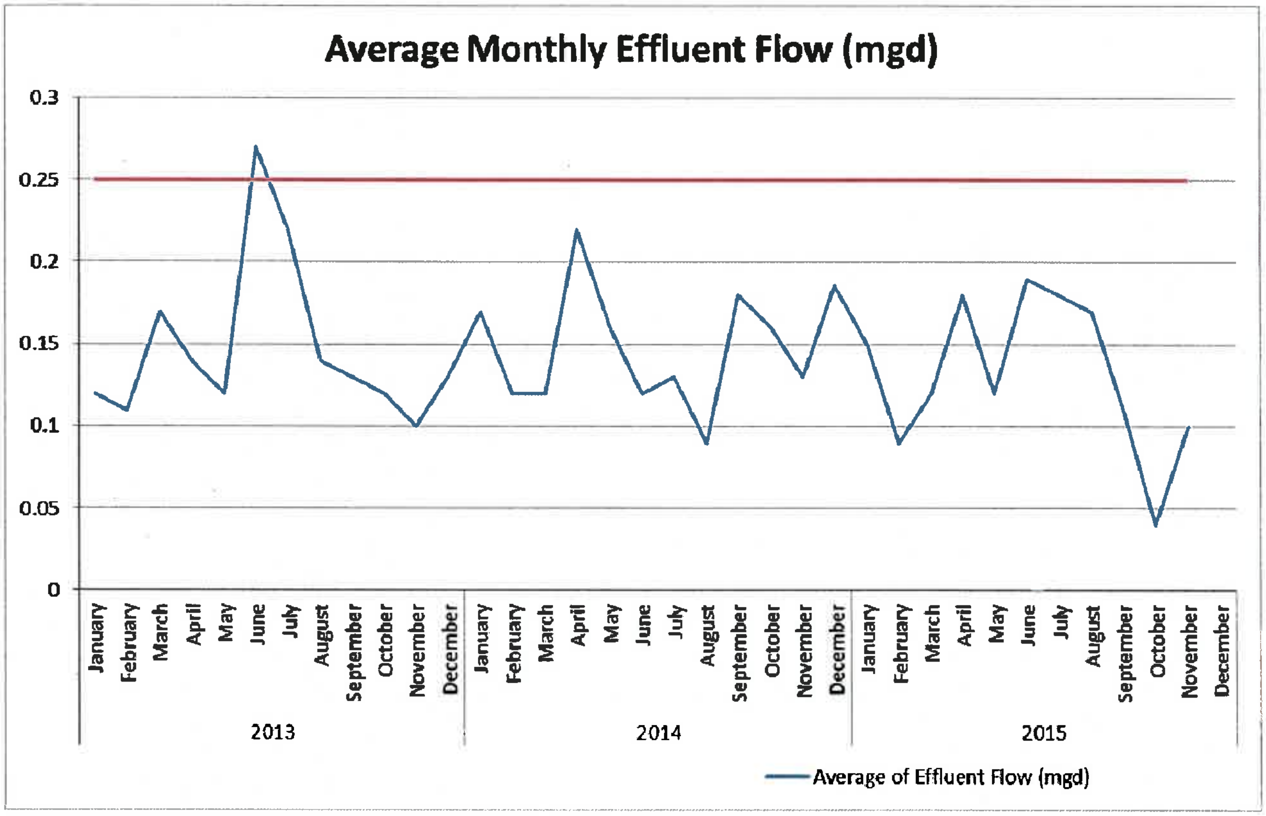


Figure 3.1: Average Monthly Effluent Flow (mgd)

Exceedance of the Hinesburg WWTF permitted average monthly effluent flow occurred in June 2013 with a average monthly flow of .27 mgd.

Information was provided by the Town on the committed reserve capacity and a copy of this May 26, 2015 Memo is provided in Appendix B.

3.3 Influent BOD and TSS Concentration

The average monthly influent BOD concentration from January 2013 through December 2015 was 311 mg/l BOD. The facility saw a maximum BOD concentration of 920 mg/l in July 2013. BOD concentrations are shown on Figure 3.2. The average monthly influent TSS concentration from January 2013 through December 2015 was 286 mg/l BOD. The facility saw a maximum

TSS concentration of 1140 mg/l in July 2013. TSS concentrations are shown on Figure 3.3. Both the BOD and TSS concentrations are higher than typical for a municipal domestic wastewater which ranges from 225 to 250 mg/l.

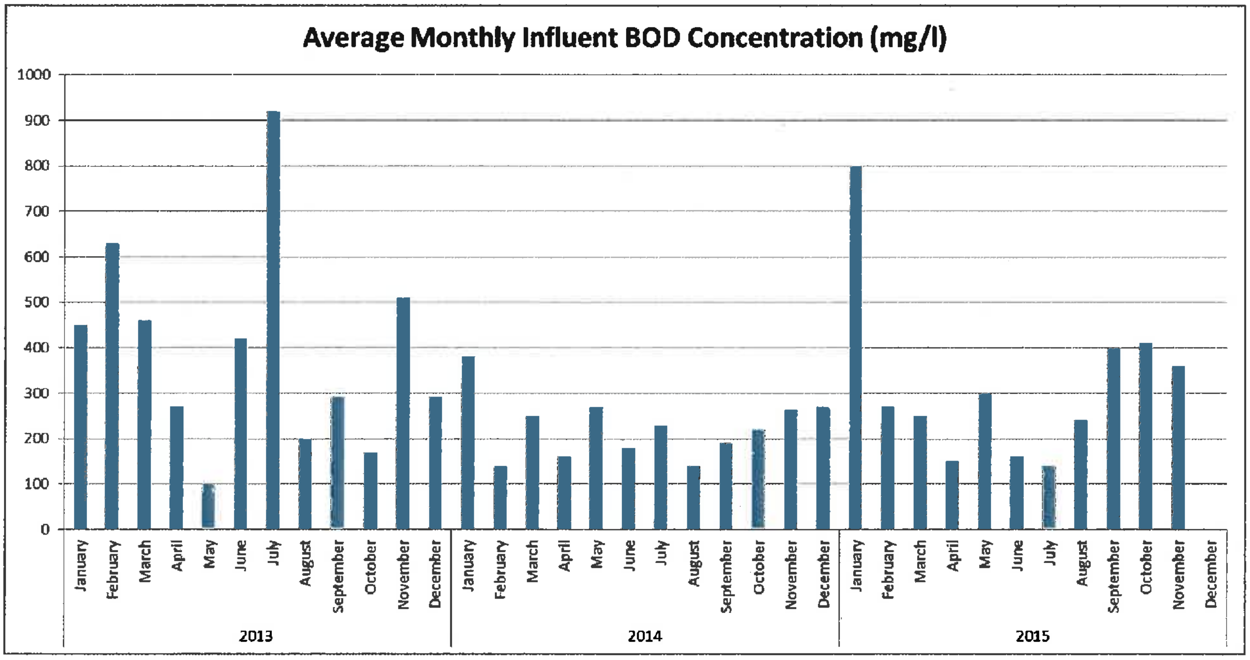


Figure 3.2: Average Monthly Influent BOD Concentration (mg/l)

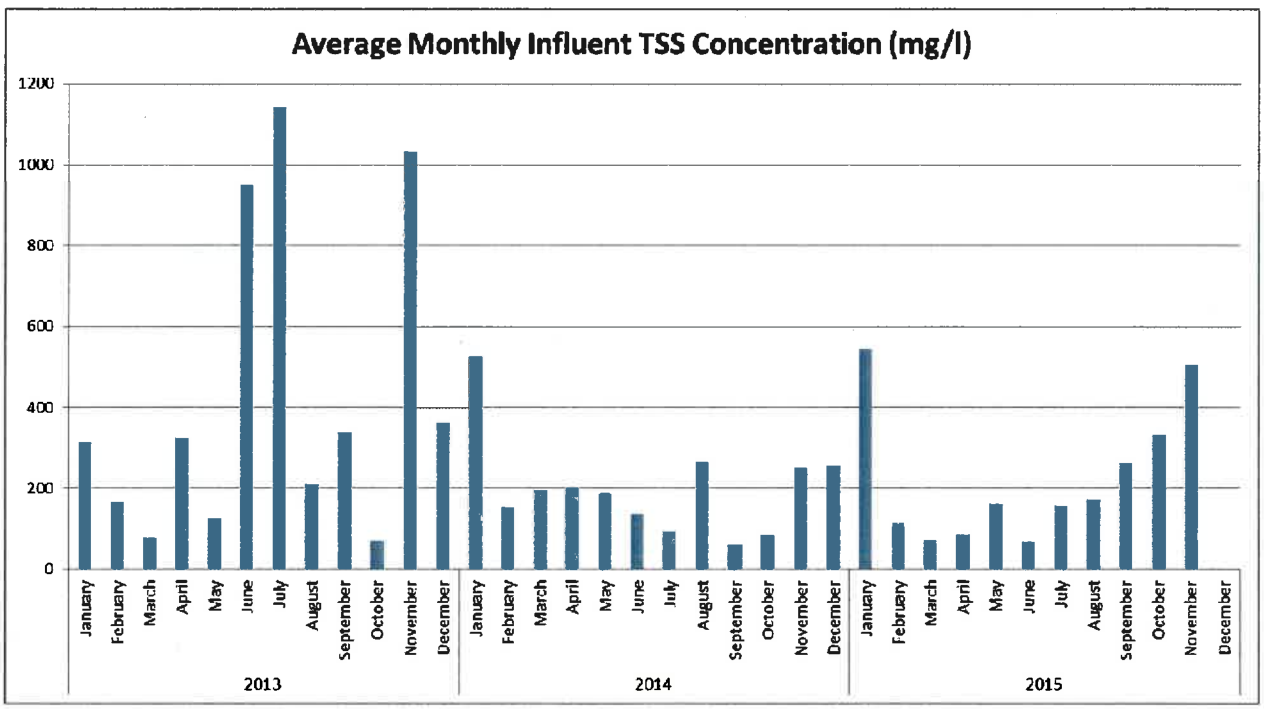


Figure 3.3: Average Monthly Influent TSS Concentration (mg/l)

3.4 Effluent BOD and TSS Concentration

The average monthly effluent BOD concentration from January 2013 through December 2015 was 7.25 mg/l. The facility saw a maximum BOD concentration of 20.1 mg/l in March 2013. BOD concentrations are shown on Figure 3.4. The average monthly effluent TSS concentration from January 2013 through December 2015 was 10.09 mg/l. The facility saw a maximum TSS concentration of 55.0 mg/l in April 2014. TSS concentrations are shown on Figure 3.5.

Both the effluent BOD and TSS consistently comply with monthly average permit limitations of 30 mg/l and 45 mg/l, respectively.

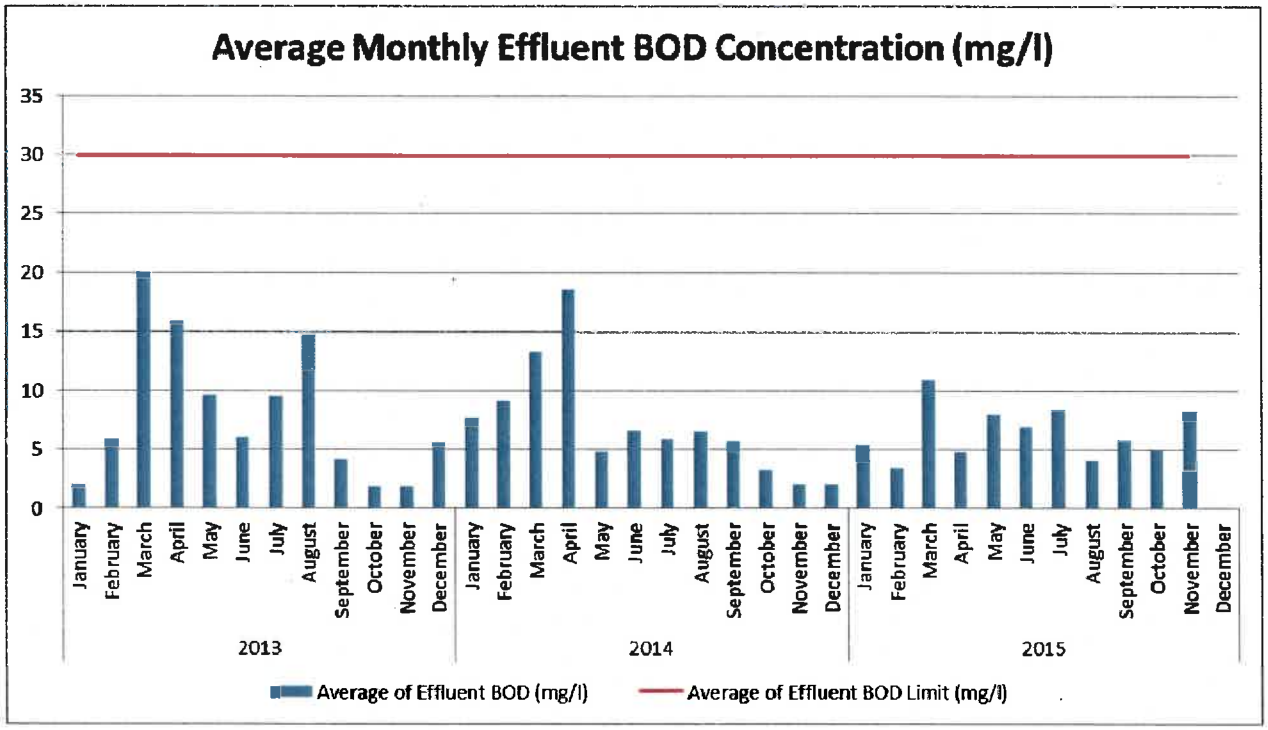


Figure 3.4: Average Monthly Effluent BOD Concentration (mg/l)

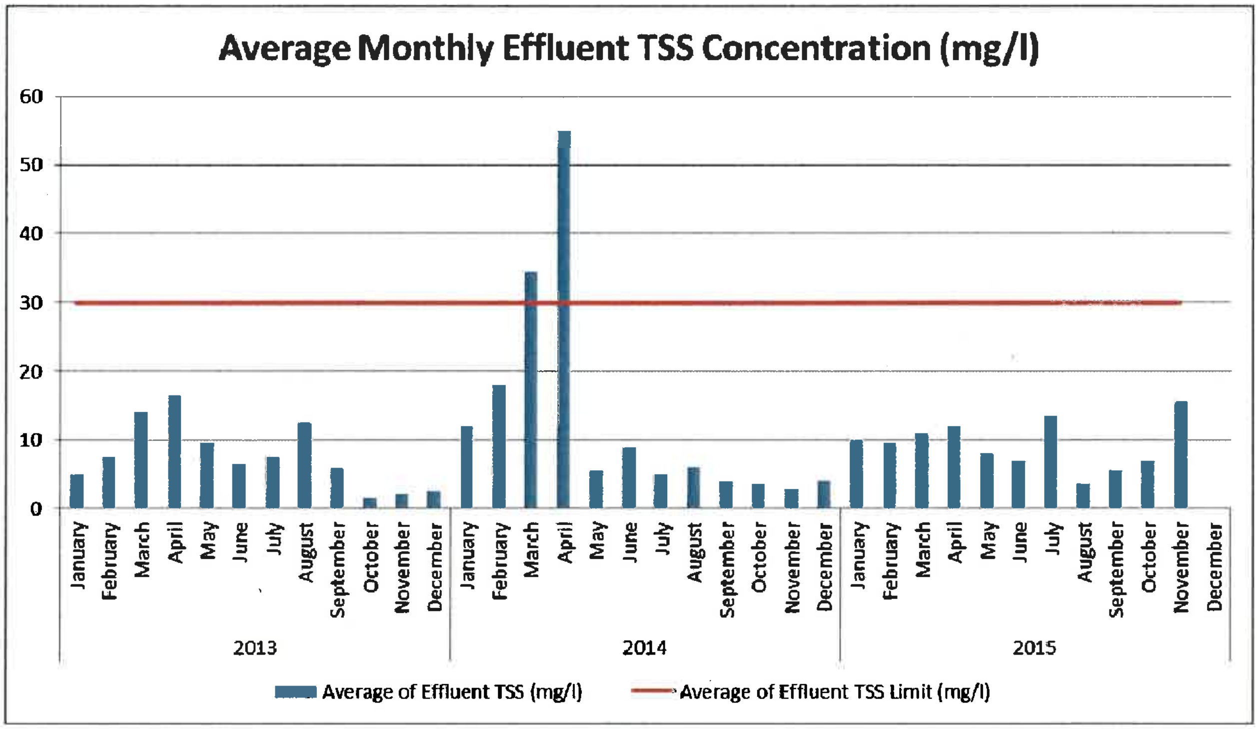


Figure 3.5: Average Monthly Effluent TSS Concentration (mg/l)

3.5 Effluent BOD and TSS Loading

The average monthly effluent BOD loading from January 2013 through December 2015 was 8.44 lbs/d. The facility saw a maximum BOD loading of 32.17 lbs/d in March 2013. BOD loadings are shown on Figure 3.6. The average monthly effluent TSS loading from January 2013 through December 2015 was 11.93 lbs/d. The WWTF saw a maximum TSS loading of 89.62 lbs/d in April 2014. TSS loadings are shown on Figure 3.7.

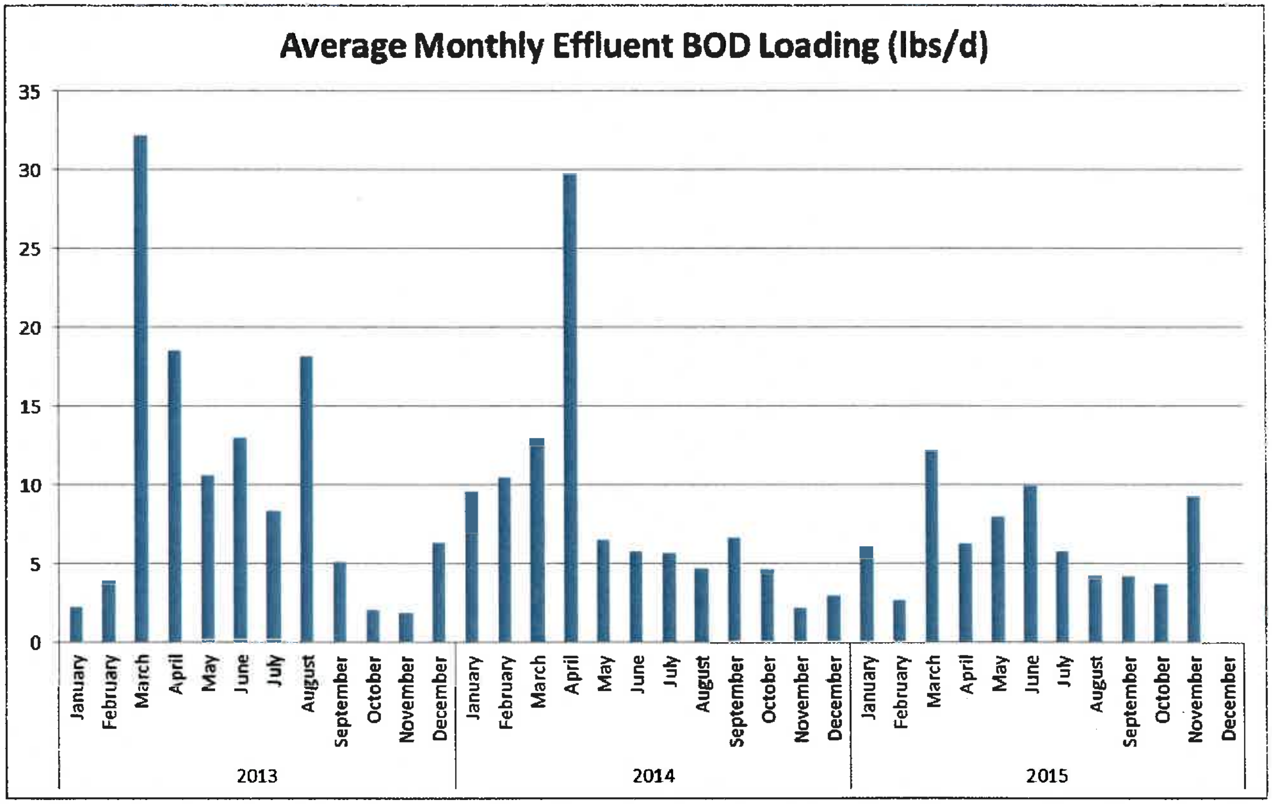


Figure 3.6: Average Monthly Effluent BOD Loading (lbs/d)

The spike in the TSS in April 2014 is consistent with the accumulated sludge depths in the last lagoon cell which caused elevated levels of total suspended solids and total phosphorus. Once the sludge was removed, the effluent concentrations returned to typical levels.

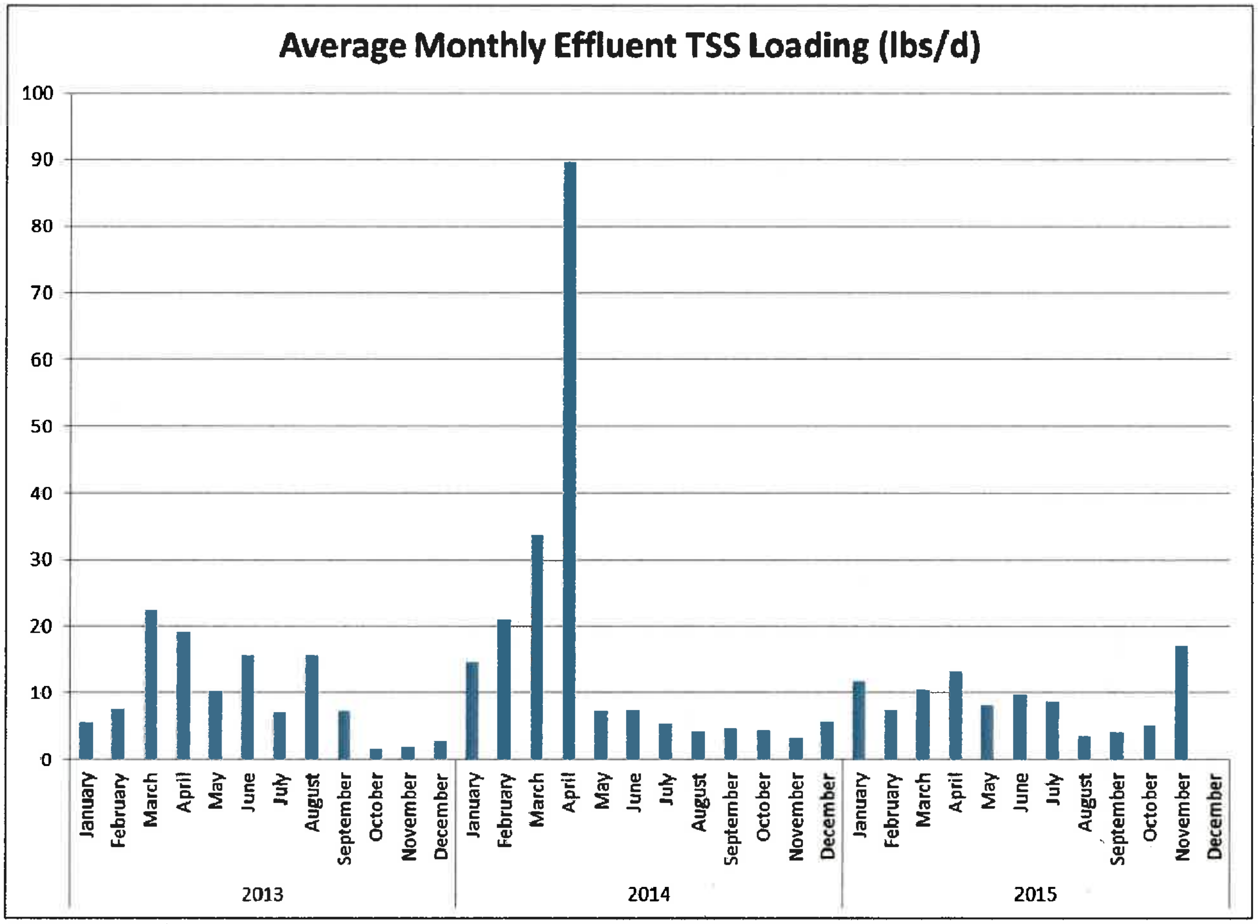


Figure 3.7: Average Monthly Effluent TSS Loading (lbs/d)

3.6 Effluent pH

The average monthly effluent pH from January 2013 through December 2015 was 7.24. The WWTF saw a minimum and maximum pH of 6.79 in November 2014 and 7.49 in June 2013, respectively. Average pH is shown on Figure 3.8.

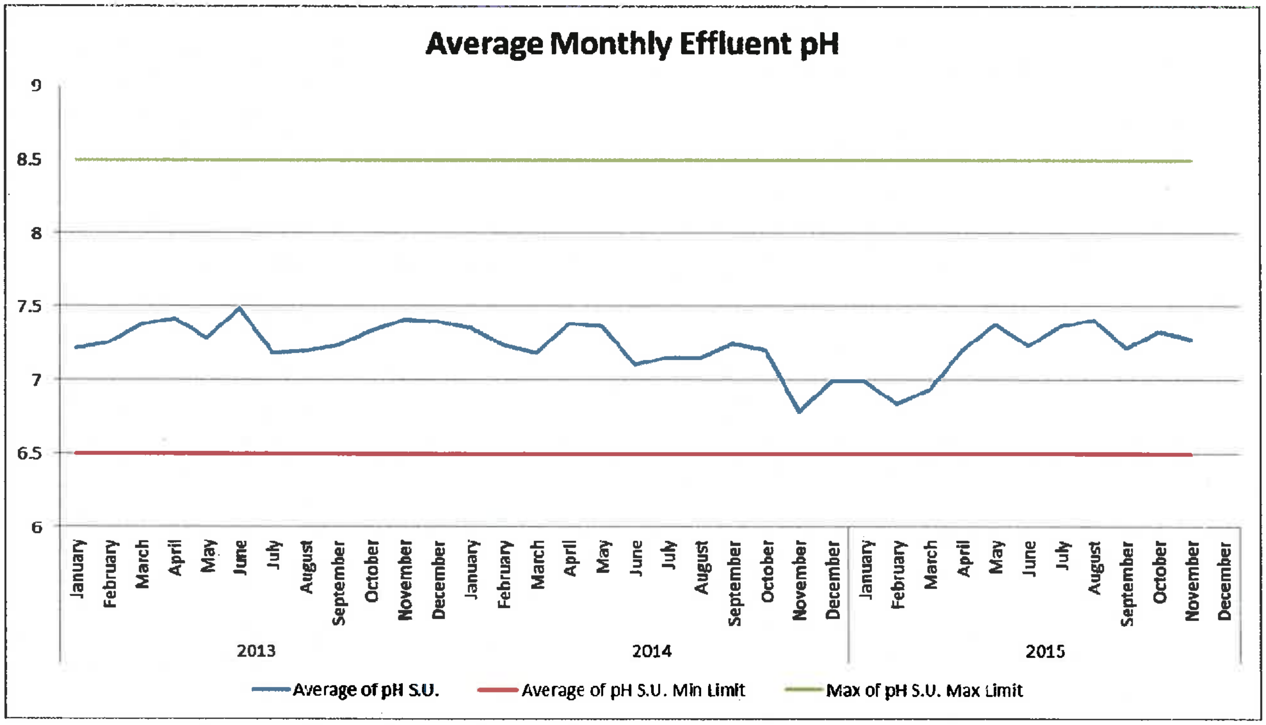


Figure 3.8: Average Monthly Effluent pH

The pH was generally consistent, ranging between 7.49 and 7.11. From November 2014 to April 2015, the pH was considerably lower. The Hinesburg WWTF did not have any pH violations from 2013 to 2015. The permitted range for pH is between 6.5 and 8.5.

3.7 Effluent Phosphorous Concentration

The average monthly effluent phosphorous concentration from January 2013 through December 2015 was 0.43 mg/l. The facility saw a maximum phosphorous concentration of 3.2 mg/l in March 2014. Phosphorous concentrations are shown on Figure 3.9. In 2015, effluent phosphorus averaged less than 0.3 mg/l.

In the spring of 2014, the phosphorus concentrations increased significantly due to the high sludge depths in the last lagoon cell. Once the accumulated sludge was removed, the phosphorus concentrations decreased significantly and were in compliance with the permit limits.

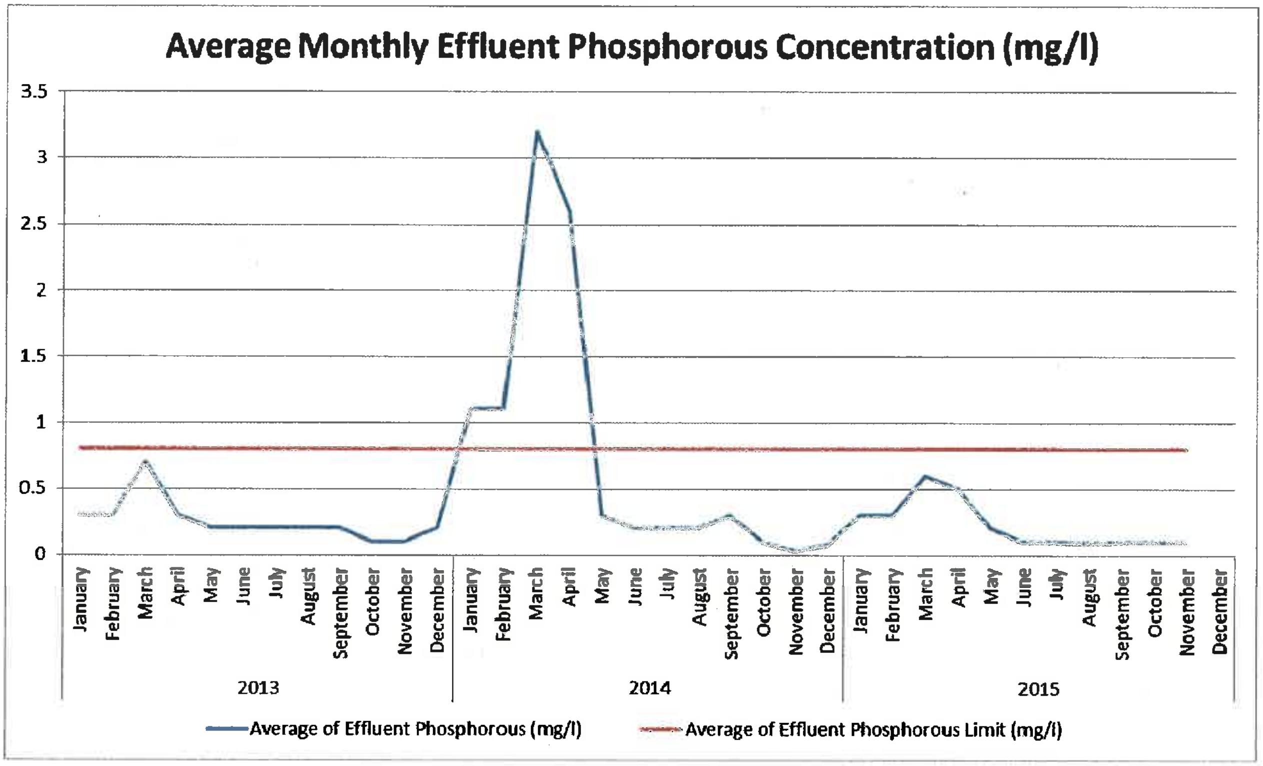


Figure 3.9: Average Monthly Effluent Phosphorous Concentration (mg/l)

3.8 Effluent Phosphorous Loading

The average monthly effluent phosphorous loading from January 2013 through December 2015 was 0.52 lbs/d. The WWTF saw a maximum phosphorous loading of 4.03 lbs/d in April 2014. Effluent phosphorous discharges loading are shown on Figure 3.10.

In 2015, about 108 lbs of phosphorus were discharged, well below the permit limit of 608 lbs.

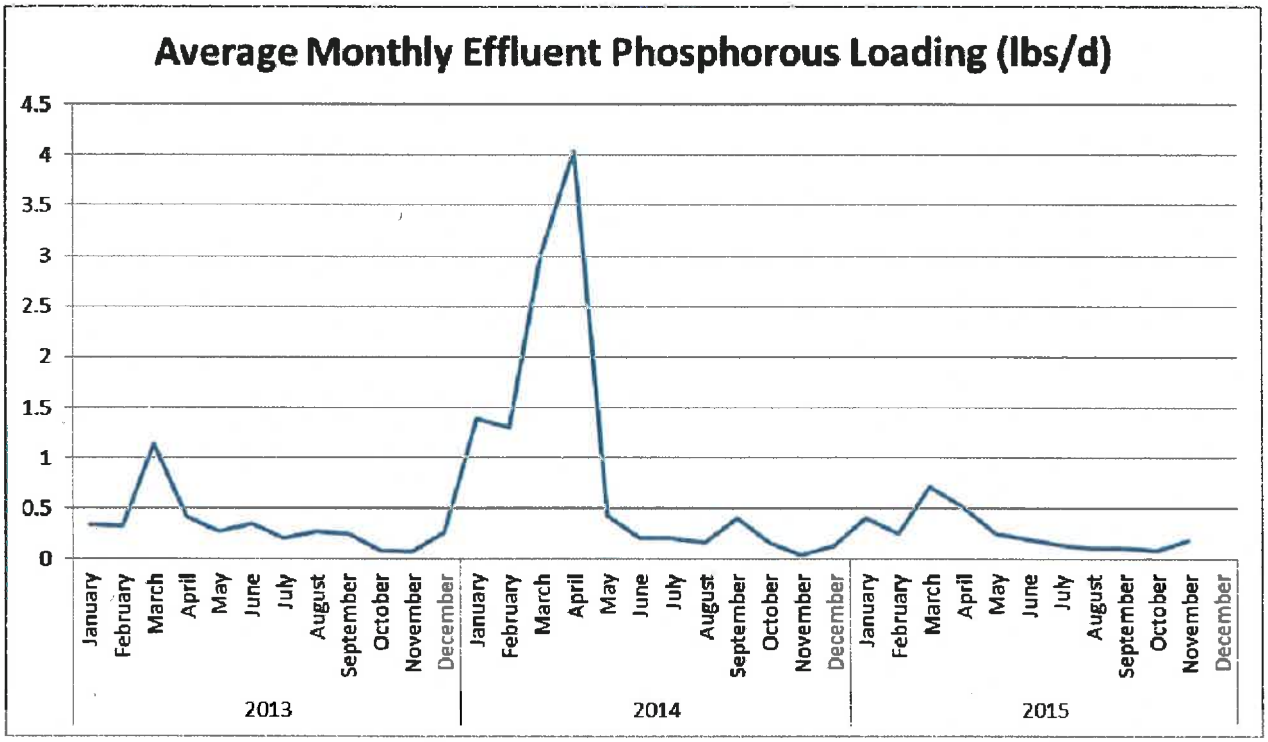


Figure 3.10: Average Monthly Effluent Phosphorous Loading (lbs/d)

3.9 Effluent Ammonia Concentration and Loading

The average monthly effluent ammonia concentration from January 2013 through December 2015 was 5.67 mg/l. The WWTF saw a maximum ammonia concentration of 11.5 mg/l in September 2015. Ammonia concentrations are shown on Figure 3.11 and sampling is only required from June through September.

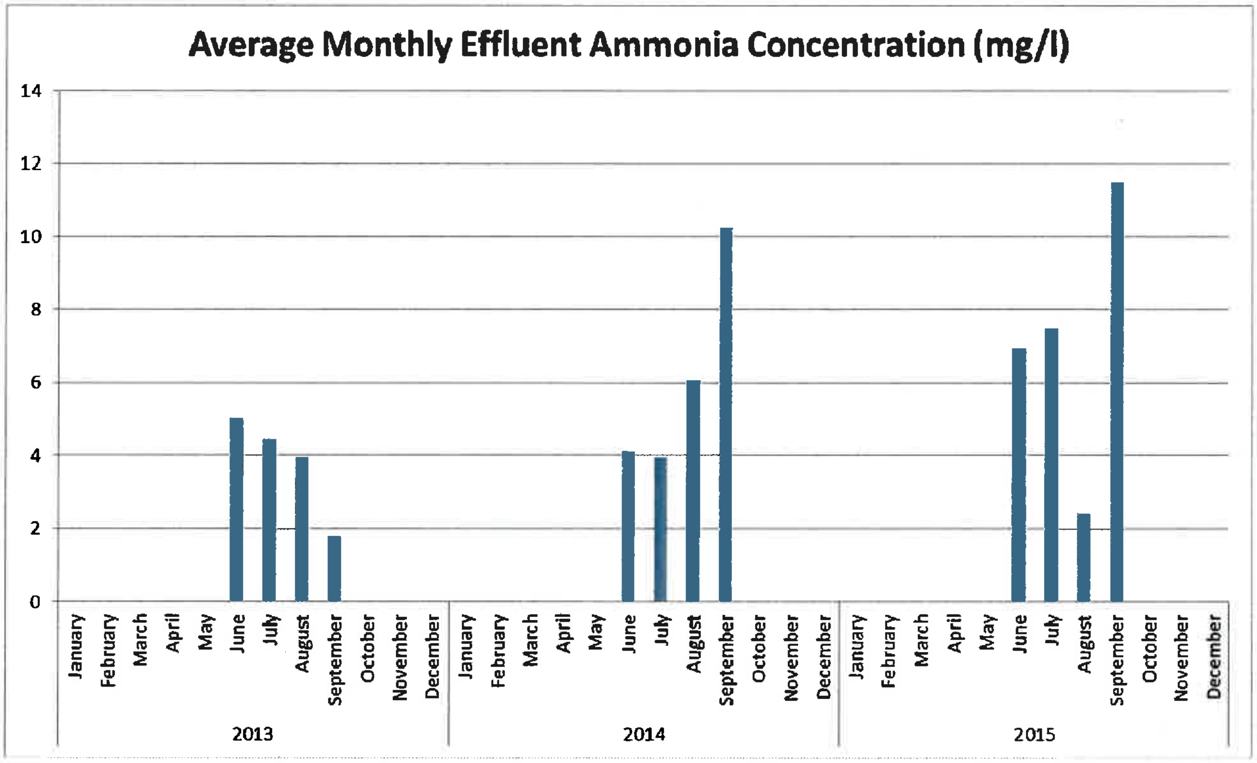


Figure 3.11: Average Monthly Effluent Ammonia Concentration (mg/l)

The average monthly effluent ammonia loading from January 2013 through December 2015 was 6.4 lbs/d. The WWTF saw a maximum phosphorous loading of 14.18 lbs/d in June 2013. Ammonia loadings are shown on Figure 3.12.

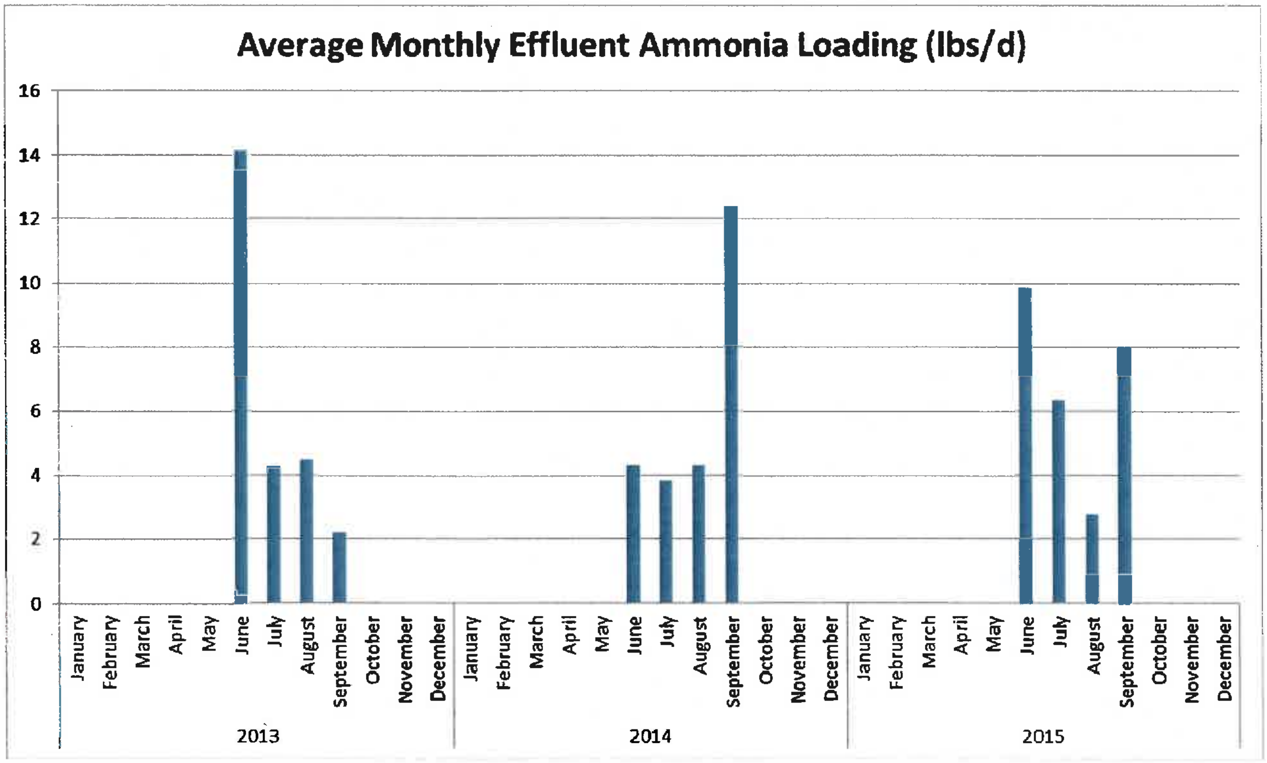


Figure 3.12: Average Monthly Effluent Ammonia Loading (lbs/d

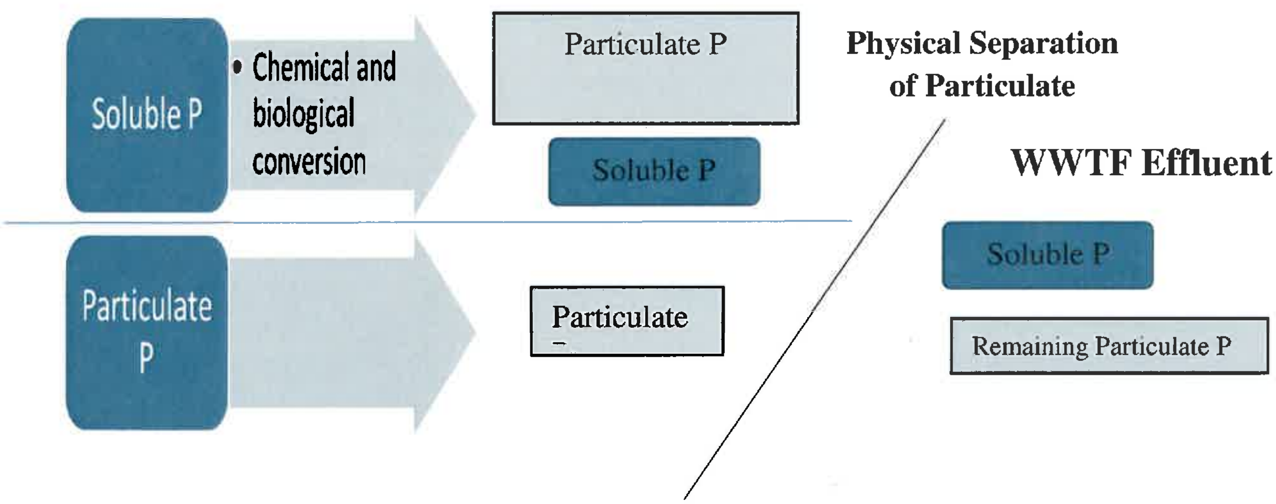
4. PHOSPHRUS REMOVAL ALTERNATIVES

4.1 Description

Tertiary phosphorus removal is a polishing step that typically treats secondary effluent. Meeting an effluent TP concentration of 0.10 to 0.20 mg/l is dependent on establishing effective chemistry to allow for soluble reactive phosphorus (orthophosphate) to be converted to particulate using a metal salt coagulant and removed from the effluent. In processes such as filtration or ballasted flocculation that depend on particle formation, tankage for coagulation and flocculation must be designed with hydraulic retention times that allow for particle formation.

There are four types of phosphorus present in wastewater:

1. Insoluble Non-Reactive: Removed by solids separation
2. Insoluble Reactive: Removed by Solids Separation
3. Soluble Non-Reactive: Very difficult to remove
4. Soluble Reactive (Orthophosphate):
    a. Precipitated with coagulant with polymer added and removed by solids separation
    b. Uptake in the biomass with biological phosphorus removal then wasted in sludge



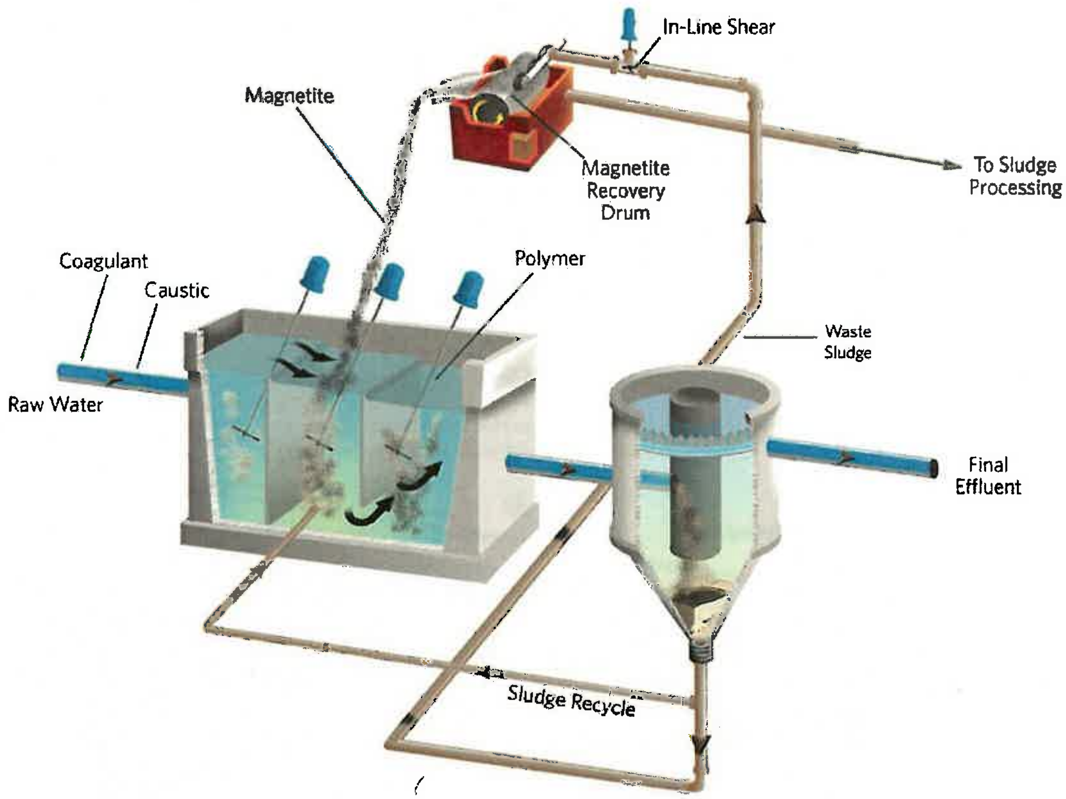
The following tertiary phosphorus removal technologies that could potentially meet an effluent TP limitation of less than 0.20 mg/l:

- Ballasted Flocculation:
    - Evoqua – CoMag
    - Veolia - Kruger Actiflo
- Continuous Upflow Filter with Reactive Media Adsorption: Blue Water Technologies - Centra-flo Filters with Blue PRO Process
- Filtration: Aqua-Aerobic Systems - Cloth Media Filter

An overview of these technologies is provided below.

4.2 Ballasted Flocculation: Evoqua - CoMag

The CoMag process is based on conventional coagulation and flocculation, and a ballast material. The ballast material is magnetite (Fe3O4), which is a fully inert, high specific gravity (5.2), finely ground, non-abrasive, iron ore. Information on the Evoqua Comag system is provided in Appendix F.

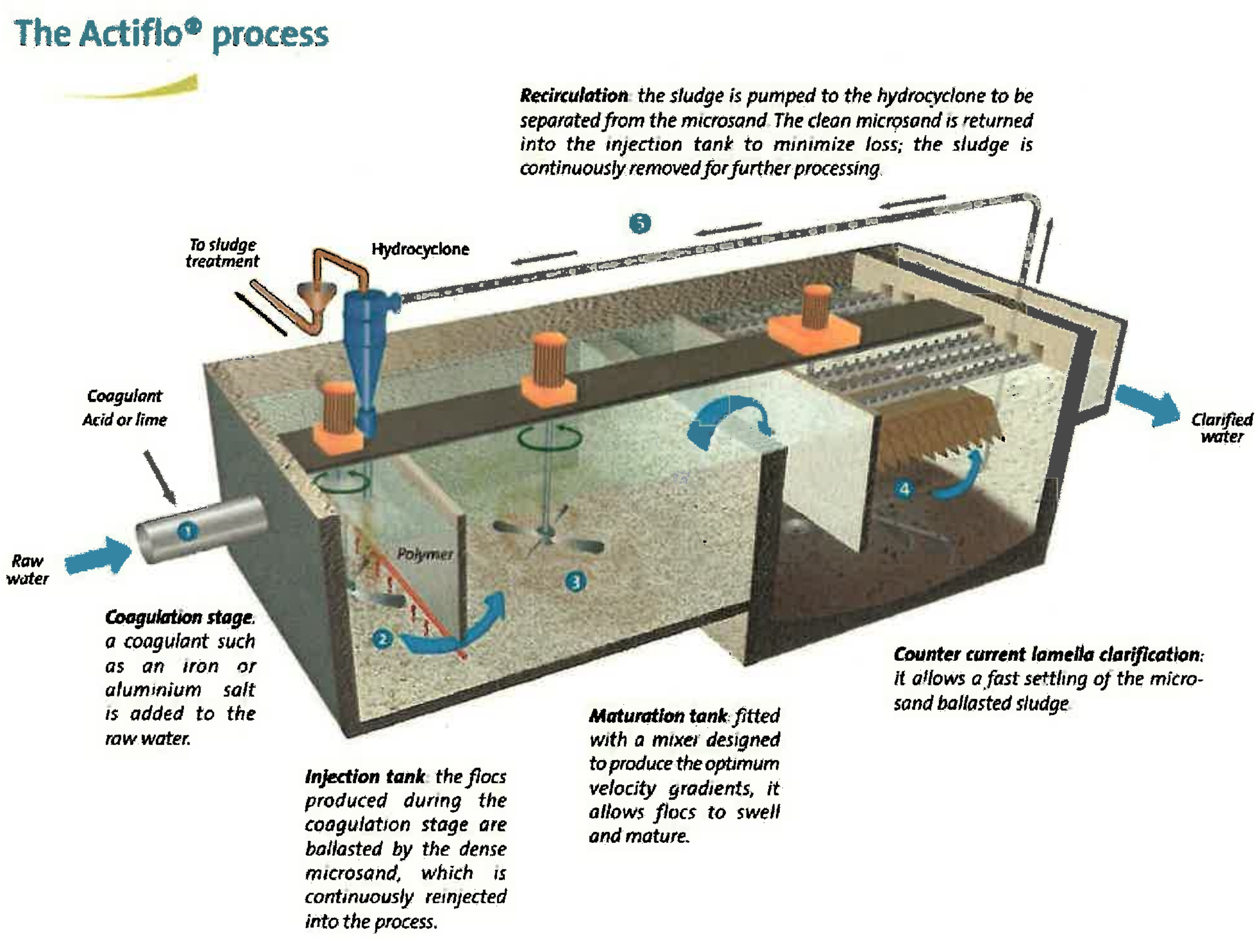


Through mixing, the magnetite is infused into the metal hydroxide floc, thereby significantly increasing the specific gravity of the floc. When the magnetite infused flocs are introduced to the CoMag clarifier, the flocs settle 20 to 60 times faster than conventional flocs or those infused with micro-sand. Rapid settling reduces required clarifier size. CoMag recycles settled solids from the clarifier back to the reaction tanks to increase nucleation sites, enhance precipitation kinetics and promote sweep floc. The magnetite ballast is recovered from the waste sludge magnetically and returned to the treatment system with very little magnetite loss.

4.3 Ballasted Flocculation: Veolia - Kruger Actiflo

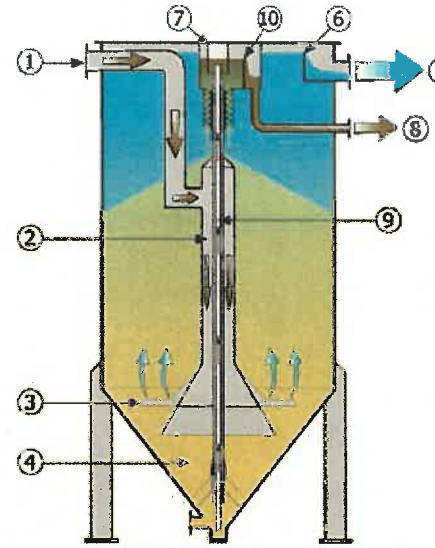
Actiflo is a high-rate wastewater clarification process in which secondary influent is flocculated with microsand and polymer. The microsand enhances the formation of robust flocs and acts as ballast, increasing their settling velocities.

The wastewater enters at point along with a coagulant (for example, ferric chloride or alum) to the injection tank where microsand and polymer are added. In the maturation tank, formation of strong flocs around the microsand is promoted. The flocculated solids flow to the clarification zone. Most of the solids settle at the bottom of this compartment, but this zone also has lamella settling modules to enhance removal of suspended solids that may be present in the wastewater. The solids accumulated at the bottom of the clarification compartment are recycled to a hydrocyclone, where the sludge is separated from the microsand. The microsand is recycled back to the injection tank, and the sludge is wasted from the system.



4.4 Continuous Upflow Filter: Blue Water Technologies - Centra-flo Filters

Centra-flo® is a gravity sand filter that utilizes counter-current filtration. Secondary effluent enters the filter through a central feed chamber. At the bottom of the feed chamber a set of radial arms evenly distributes the secondary effluent to the media bed. Water flows upward through the filter media, which retains suspended solids, contaminants and nutrients, depending on the application. The filtrate fills the headspace above the media bed and flows over a fixed effluent weir at the top of the filter. A portion of the filtrate passes through the washbox at the top of the central assembly and carries away the separated solids, contaminants and nutrients in the reject stream. As the airlift transports the dirtiest sand to the washbox, the media bed moves downward at a steady rate.



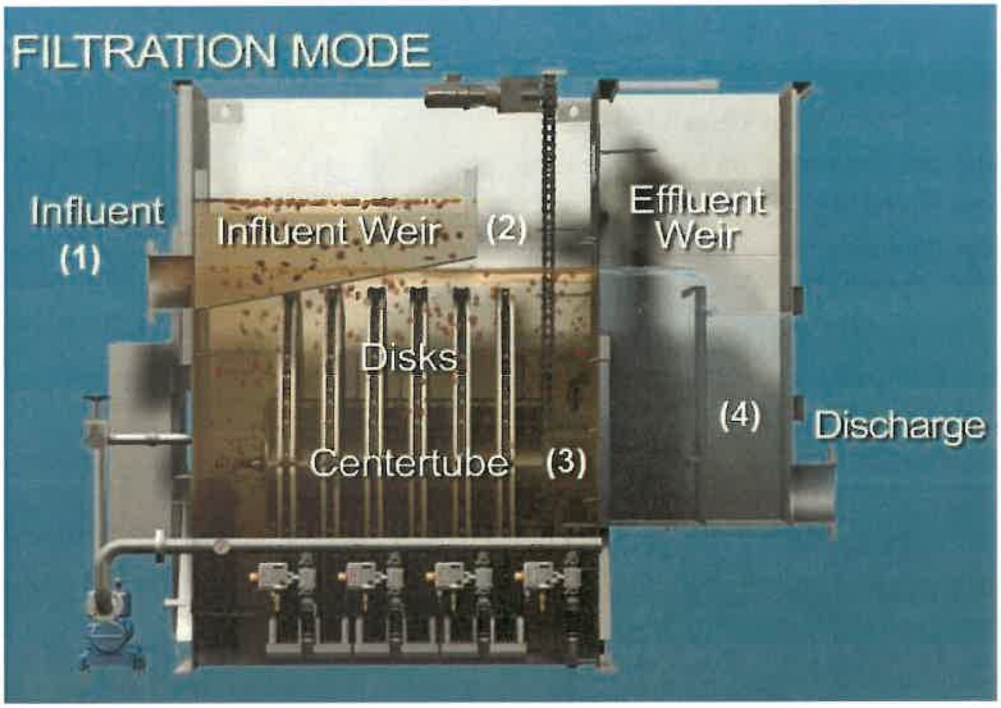
1. Influent
2. Central Feed Chamber
3. Radial Arms
4. Spherical Silica Media
5. Filtrate
6. Fixed Effluent Weir
7. Washbox
8. Reject Stream
9. Airlift
10. Adjustable Reject Weir

Solids and contaminants retained by the filter media are drawn downward into a recessed chamber in the filter's lower cone. The high-energy turbulence inside the airlift provides a scrubbing action that separates the sand and the captured solids before discharging them to the washbox at the top of the filter. The washbox is a baffled chamber that allows for counter-current washing and gravity separation of the filter media and the lighter captured solids. The separated solids and contaminants are carried away by the reject portion of the filtrate, while the scrubbed media falls by gravity to the top of the filter bed to resume the cycle.

Blue Water's reactive filtration process provided reactive surface sites within the media bed, resulting in forced contact of chemical species with high adsorptive capacity. The adsorptive surface in Blue PRO® filters is a continuously regenerated hydrous ferric oxide (HFO) coating that forms on the surface of the silica media. Waste HFO, phosphorus, metals and solids are removed from the filter through the reject stream. The reject stream is recycled upstream of the secondary clarifiers for settling. The phosphorus and metals are chemically bound solids which settle and are wasted with secondary solids.

4.5 Filtration: Aqua-Aerobic Systems - Cloth Media Filter

The influent pipe (1) routes flow to the filter basin (2), where filtration occurs. The filter basin contains a series of circular disks covered with a pile cloth media. As water passes through the media via an outside-in flow path, some particulates are removed and stored within the pile cloth media while others are deposited on the pile cloth media surface. Filtered water, or filtrate, is collected in a centertube (3) and flows, via gravity, over the effluent weir and into the effluent chamber (4) prior to discharge. The disks do not rotate during filtration.



Normal Operation

As more particulates are deposited on and within the pile cloth media, the pressure required to drive water through the pile cloth media (headloss) increases. This results in a rise in the water level within the filter basin and increased differential pressure on the pile cloth media. Upon reaching a specific basin water level set point, the PLC automatically initiates the backwash mode to clean the pile cloth media.

Solids are backwashed from the pile cloth media surface by liquid suction through backwash shoes positioned on both sides of each disk. These spring loaded backwash shoes contact the pile cloth media to provide the necessary suction for cleaning. During backwash, disks are cleaned in multiples of two, unless the filter has only one disk. The disks rotate slowly while a backwash/waste pump draws filtered water from the centertube through the pile cloth media on an inside-to-outside, or reversed, flow path. This provides cleaning of the pile cloth media over the entire disk. By the end of the backwash cycle, the basin water level returns to its normal operating level. Backwash water is typically directed to the headworks. Filtration continues while the filter is in backwash mode. This allows for continuous filtration.

5. AERATED LAGOON EXPANSION/UPGRADES

5.1 Background

When the wastewater treatment facility was upgraded in 2009, the project included future plans for increase of the permitted flow from 0.250 to 0.308 mgd. However, at that time with the Saputo facility closure, the Town didn't need this additional capacity, so the Discharge Permit was not amended. Design of the following equipment for the upgrade was based on the flow of 0.308 mgd:

- Main pump sewage pumps and controls
- Aerated lagoon air distribution piping and partial mix aeration system
- Alum feed and storage system
- Positive displacement blowers
- Chorine contact tank and disinfection feed and storage system

Approvals of this larger equipment for the 0.308 mgd was provided by the State DEC Wastewater Division through the Basis for Final Design process.

The Town wants to continue to explore this expansion approach, so this alternative is evaluated further.

5.2 Proposed Permit Limits

A summary of the permitted effluent limitations are provided in Table 5.1 at the permitted flow of 0.308 mgd. Under this scenario, the mass loadings (lbs) will need to remain the same at this higher flow and changes to the total phosphorus limit are anticipated with the new Lake Champlain TMDL issued by EPA on June 17, 2016. In the previous schedule, the Town of Hinesburg's Discharge Permit renewal was to be issued in 2016 to include the lower total phosphorus limit but this has been delayed. Based on TMDL, the Town of Hinesburg's total phosphorus limit will decrease from 608 to 152.2 lbs per year. This lower wasteload allocation (WLA) is based on the permitted flow of 0.250 mgd and a total phosphorus concentration of 0.2 mg/l. At the increased flow of 0.308 mgd, a total phosphorus concentration of 0.16 mg/l will be required to comply with the lower WLA.

Recent discussions were also conducted with the State DEC Watershed Management Division about any other potential permit limitations of concern for this segment of the LaPlatte River. Concerns were raised about the impacts of ammonia discharges relative to compliance with the Water Quality Standards. Presently, there is no ammonia limit discharge specified as it is monitor only. During the June to September monitoring period, the ammonia discharges ranged from 4.7 to 12 mg/l. A letter dated February 11, 2016, was issued by DEC outlining concerns about the ammonia discharges and the ability to manage these discharges at the higher flow of 0.308 mgd to comply with the Water Quality Standards. A copy of this letter is provided in Appendix C.

Based on recent discussions with State DEC staff, the next permit renewal will likely include a requirement for additional ammonia monitoring and possibly a compliance schedule.

Table 5.1
Permitted Effluent Limitations

Effluent Characteristics	Annual Limits	Monthly Average	Weekly Average	Maximum Day	Instantaneous Maximum
Flow (Annual Average)	0.308 mgd	---	---	---	---
Ultimate Oxygen Demand[1]	---	---	---	400 lbs/day	
Biochemical Oxygen Demand (BOD_5)	---	30 mg/l 63 lbs/day	45 mg/l 94 lbs/day	50 mg/l	---
Total Suspended Solids (TSS)	---	45 mg/l 94 lbs/day	45 mg/l 94 lbs/day	50 mg/l	---
Total Phosphorus (TP)	152.2	---			
Total Residual Chlorine	---	---	---	---	0.1 mg/l
Total Kjeldahl Nitrogen (TKN)				Monitor only	
Ammonia		< 10 mg/l			
Settleable Solids	---	---	---	---	1.0 ml/l
E. Coli	---	---	---	---	77/100 ml
pH	---	Between 6.5 and 8.5 Standard Units			

Notes:

1. Ultimate oxygen demand limitation shall apply from June 1 through September 30.

5.3 Ammonia Removal Alternatives

To provide consistent year round compliance with a lower ammonia limit, retrofit treatment technologies for the aerated lagoon were evaluated. Compared to other treatment technologies, consistent ammonia removal with an aerated lagoon is very challenging, especially during the cold weather periods. Ammonia removal to levels less than 5.0 mg/l via nitrification is very achievable with other treatment processes, but for an aerated lagoon, these factors must be considered:

- Adequacy of air supply to maintain sufficient dissolved oxygen levels
- Providing the majority of the BOD removal prior to meeting the air supply needs for nitrification
- Maintaining a suitable pH between 7.5 – 8.0 SU

- Suitable water temperatures in colder weather conditions
- Reduction of accumulated sludge volumes
- Maintaining adequate mixing

To meet these objectives, extensive work is required to modify the aerated lagoons and may require the following upgrades;

- Larger aeration blowers, air distribution line, and aeration diffusers
- Creating a complete mix zone at the influent to optimize the biochemical oxygen demand (BOD) removal
- Providing additional alkalinity to optimize the pH range
- Covering a majority of the lagoons to maintain minimum temperatures
- More frequent sludge cleanouts to minimize the sludge depths

An initial screening of solutions to better optimize the ammonia removal for the aerated lagoons was performed and some of these available technologies are:

- Breakpoint chlorination
- Lemna Technologies LemTec Biological Treatment Process
- Environmental Dynamics IDEAL (Intermittently decanted extended aeration lagoon)

A brief description and evaluation of each of these technologies is provided in the following narratives.

5.3.1 Lemna LemTec

Description

The Lemna LemTec (LBTP) system is promoted as an effective, reliable, and affordable aerated lagoon based biological treatment process which utilizes a series of aerobic treatment cells followed by a settling zone and a polishing reactor. This LemTec process can be capable of achieving year-round effluent limits of 20 mg/l BOD_5, 20 mg/l TSS, less than 1 mg/l NH_3 and 0.8 mg/l P.

For this proposed lagoon upgrade, the LemTec proposal utilizes two of the existing four lagoons with depths of 10' to handle a design flow of 0.308 mgd. All of the lagoon cells are covered by an insulated modular cover. The cover prevents algae growth by eliminating sunlight below the cover and improves clarification.

Influent flow enters the first lagoon which is divided into 3 individual cells as follows:

- The first cell will be a complete mix cell utilizing high rate aeration diffusers to significantly reduce the BOD_5 strength. In addition, ammonia is also removed by heterotrophic bacteria present in this complete mix cell.
- Flow continues into two partially mixed cells utilizing low rate diffusers to further reduce the BOD_5.

Phosphorus removal in this system is achieved by chemical addition within a rapid mixing chamber and flocculation in the settling cell of the treatment lagoon. This chemical dosing system is located in the influent end of the second lagoon.

The second lagoon serves as a settling pond with a detention time of approximately 9.2 days to provide a quiescent zone for solids to settle.

Downstream of the second lagoon, a polishing reactor will provide additional BOD and ammonia removal. This reactor consists of submerged, attached-growth media to maintain an adequate population of bacteria.

Additional information on this Lemna system is provided in Appendix D.

Advantages

- The covered aeration cells help to maintain wastewater temperatures for optimizing ammonia removal
- The covered settling cell prevents algae growth and improves clarification
- Operates with a reduced footprint

Disadvantages

- Since this system reuses the existing lagoons, installation of a new synthetic liner will be required to replace the existing bentonite liner.
- Phosphorus removal is achieved, but not to the lower limits anticipated in the P TMDL. Additional treatment components will be required to maintain consistent compliance with the lower limits.
- Effluent pumping will be required to maintain gravity flow through the phosphorus removal system
- Sludge accumulation will continue to occur in the second lagoon

5.3.2 Environmental Dynamics IDEAL Solution

Description

The EDI intermittently decanted extended aeration lagoon (IDEAL) bioreactor converts the existing lagoons to this intermittently decanted extended aeration lagoon.

This IDEAL bioreactor is a constant inflow, batch outflow process, similar to a sequencing batch reactor system. The result is a high level of treatment and four hours of water flow released over the course of an hour during normal operation. A post-treatment basin provides the system with a means to normalize water flow after treatment.

Disc filtration is proposed as an option to maximize removal of TSS, BOD, and phosphorus.

A sludge digestion basin is required to manage the excess bio-solids that will be generated from this process. These excess solids must be removed on daily basis from the biological digester, concentrated, and then disposed.

Additional information on this IDEAL system is provided in Appendix E.

Advantages

- Reuse existing lagoons for the bioreactor and flow equalization
- Proven cold temperature nitrification
- Nitrate and total nitrogen removal
- Easily adjusts to varying degrees of flow and organic loading
- Minimum operator attention

Disadvantages

- Since this system reuses the existing lagoons, installation of a new synthetic liner will be required to replace the existing bentonite liner
- Limited water depth in the lagoons makes conversion to the IDEAL system more challenging for upgrade and operations
- Lagoons are not covered to maintain temperatures for optimizing nitrification
- Effluent pumping will be required to maintain gravity flow through the phosphorus removal system
- Phosphorus removal is achieved, but not to the lower limits anticipated in the P TMDL. Additional treatment components will be required to maintain consistent compliance with the lower limits.
- Daily wasting and managing of sludge is required.

5.4 Phosphorus Removal Alternatives

For the aerated lagoon facility to comply with the lower phosphorus limit at the increased flow of 0.308 mgd, alternatives were evaluated for tertiary phosphorus removal. Addition of phosphorus removal at these low levels of 0.16 mg/l is very difficult for an aerated lagoon facility because of the higher total suspended solids discharges and influence of algae. The following technologies could be applicable for the lagoon upgrades.

- Ballasted flocculation
  - Veolia Kruger Actiflo
  - Evoqua CoMag
- Reactive sand filters
  - Blue Pro Centra-flo continuous backwash

None of the above processes provide the added benefit of improving the removal of ammonia, so these upgrades are evaluated separately. Additional information on phosphorus removal alternatives is provided in Section 4.0.

5.5 Conclusions

For addressing a future ammonia limit at a permitted flow of 0.308 mgd, both the Lemna LemTec and EDI IDEAL systems have experience with upgrading aerated lagoons to consistently comply with a lower year round ammonia limit. This upgrade could be implemented for an estimated cost of about $3.0 M. There are advantages and disadvantages to each of these systems, but the major limitation is phosphorus removal. Neither of these systems have the capability to optimize phosphorus removal and comply with a lower limit of 0.2 mg/l.

In addition to these lagoon upgrades, addition of effluent pumping and phosphorus removal technology will be required to comply with the lower phosphorus limit. Because of the continued operation of the lagoons, use of filtration is somewhat limited. To optimize phosphorus removal for the lagoons, the estimated cost will range from $3.5 to $5.0M based on similar size facilities and will be in addition to the upgrades required to remove ammonia.

6. EXPANSION TO 0.450 MGD

6.1 Description

Given the limitation on achieving year round nitrification for ammonia removal, the Town could consider other treatment process alternatives when considering expansion to a treatment capacity of 0.450 mgd. The sequencing batch reactor (SBR) process was identified as a suitable representative process for achieving year round nitrification, and is used herein for comparison. Other similar process alternatives that could be considered are conventional activated sludge, extended aeration or oxidation ditches.

Based on the most recent information provided in the Lake Champlain TMDL for Phosphorus, the Hinesburg WWTF would have an annual waste load allocation equivalent to 0.2 mg/l TP at the permitted discharge of 0.250 mgd. If the capacity were increased to 0.450 mgd, the waste load allocation would remain constant. Therefore, it would be equivalent to 0.11 mg/l total phosphorus concentration at the permitted discharge of 0.450 mgd.

Siting of this new facility would be on the Town owned property either at the existing treatment facility or to the east along the LaPlatte River as shown on Figure No. 2 in Appendix A. Construction at the easterly end of the parcel is easier construction, but this area is located in the FEMA Special Flood Hazard Area. As an option, the new SBR could be located in the existing lagoon #2 and still allow continuous operation of the existing facility. Further investigation of the siting of this new facility would need to be done once an approach is selected.

To convert the Hinesburg WWTF to a SBR facility and meet the expected effluent limitations, the following process elements be required:

- Headworks with screening and grit removal
- Two (2) SBR tanks, controls, pumps, blowers and other related equipment
- Flow equalization post SBR
- New sludge holding tanks/sludge disposal
- Tertiary phosphorus removal system designed to meet 0.11 mg/l total phosphorus
- Disinfection

A process flow schematic of this SBR facility is provided on Figure No. 3.

A Headworks building to house screening and grit removal equipment would be required for a SBR facility as well as other possible process alternatives. Removing excess debris from the influent stream both benefits and protects downstream equipment and allows for effective settling and process treatment.

SBR systems are a variation of an activated sludge process where all steps of the process are performed in a single basin. The SBR basin operates in the following modes: fill, react, settle, decant, and idle. Refer to Figure No. 4 for a schematic on the operation of an SBR treatment system and additional design criteria is provided in Appendix G. A minimum of two basins are required to allow for continuous influent flow. Blowers, pumps, controls, and other miscellaneous equipment would be housed in a new building. Two (2) new in-ground concrete tanks would be constructed for the SBR basins. Flow equalization would be provided following the SBR system to reduce required hydraulic capacities of the tertiary phosphorus removal and disinfection systems.

Effluent from the SBR's continues through three (3) cloth media filters. The filter basin contains a series of circular disks covered with a pile cloth media. As water passes through the media via an outside-in flow path, some particulates are removed and stored within the pile cloth media while others are deposited on the pile cloth media surface. Filtered water, or filtrate, is collected in a centertube (3) and flows, via gravity, over the effluent weir and into the effluent chamber (4) prior to discharge. Additional detail on the cloth media filters is provided in Section 4.5

Disinfection will be provided by open channel ultraviolet disinfection, or liquid chlorination/dechlorination.

Waste sludge generated during the SBR process would be stored on-site in two (2) new aerated sludge holding tanks. Blowers would provide air to diffusers in the storage tanks to keep the sludge aerobic and prevent odors. Liquid sludge would be periodically pumped out of the sludge holding tanks for landfill disposal. Sludge management operations and disposal costs are significantly higher than with a lagoon treatment system.

6.2 Estimated Costs

Budget costs for the new SBR treatment system was obtained from vendors and information from similar size and type facilities was used to estimate the cost of this new larger facility. Costs for this larger facility will range from $9.0 to $10.0 M, and annual operating costs will increase to about $450,000.

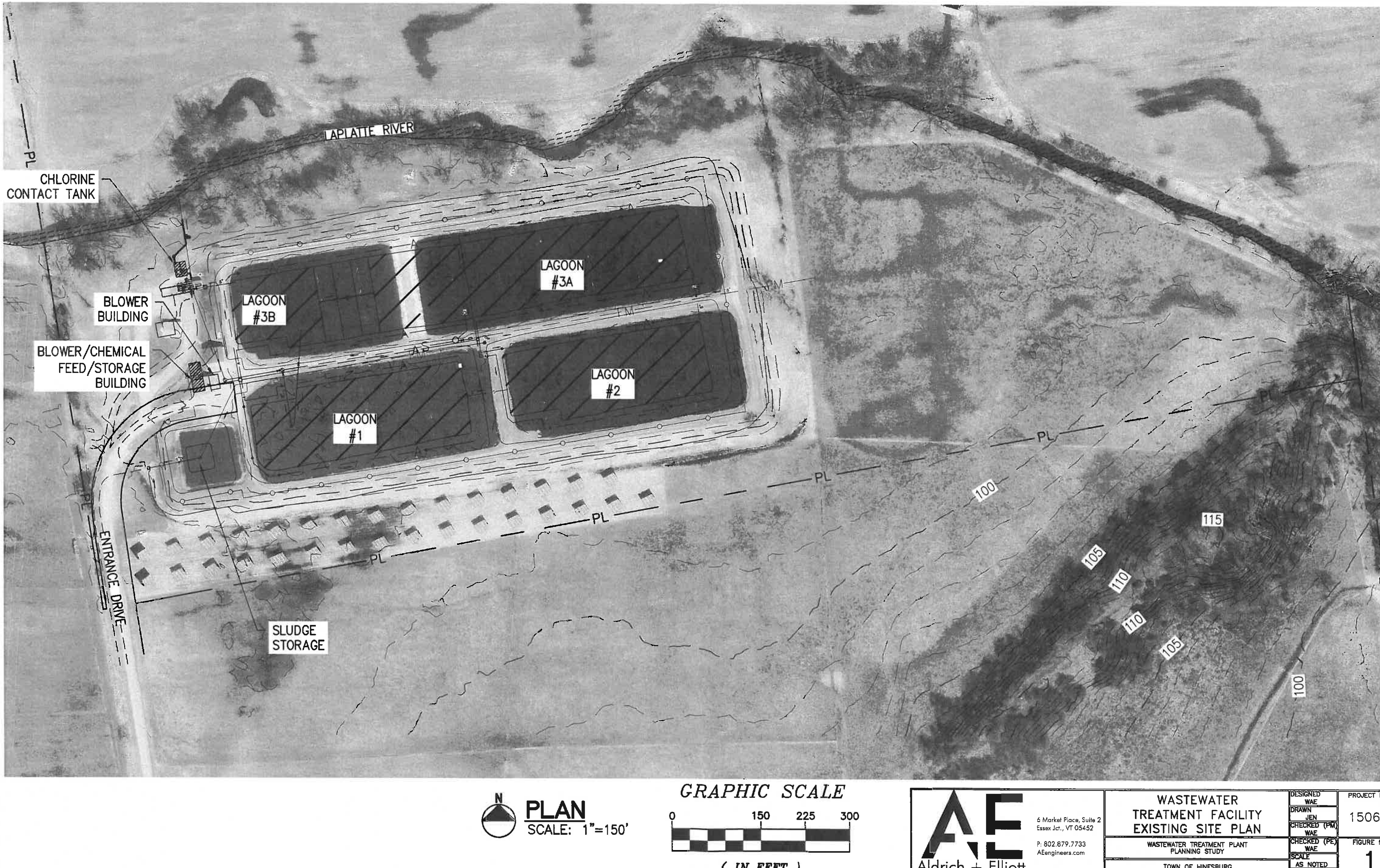
6.3 Conclusions

Since the Town has adequate space at the existing site, construction of a new facility needs to be strongly considered as it provides more treatment capacity to meet the future build-out needs and will have the capability to provide consistent compliance with the lower phosphorus limit and year round ammonia limit at a similar cost to upgrading the existing lagoon facility for both ammonia and phosphorus removal.

APPENDICES

APPENDIX A

Figures



Aldrich + Elliott WATER RESOURCE ENGINEERS
6 Market Place, Suite 2 Essex Jct., VT 05452
P: 802.879.7733
AEengineers.com

WASTEWATER TREATMENT FACILITY EXISTING SITE PLAN

WASTEWATER TREATMENT PLANT PLANNING STUDY

TOWN OF HINESBURG

HINESBURG VERMONT

DESIGNED	WAE
DRAWN	JEN
CHECKED (PM)	WAE
CHECKED (PE)	WAE
SCALE	AS NOTED
DATE	JULY, 2016
PROJECT NO.	15063
FIGURE NO.	1

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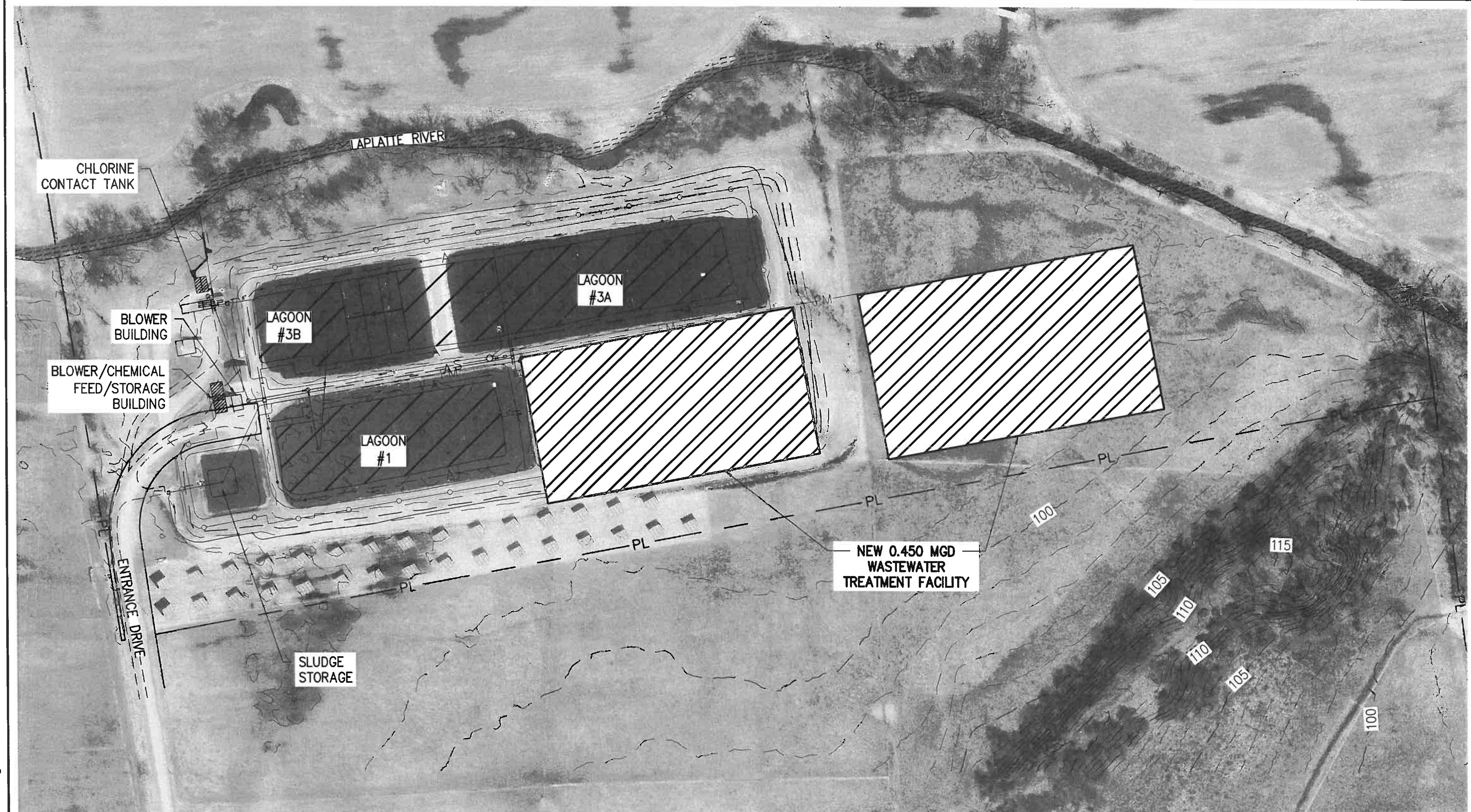

PLAN
SCALE: 1"=150'

GRAPHIC SCALE
0 150 225 300
(IN FEET)

Aldrich + Elliott WATER RESOURCE ENGINEERS 6 Market Place, Suite 2 Essex Jct., VT 05452 P: 802.879.7733 AEengineers.com	WASTEWATER TREATMENT FACILITY OVERALL SITE PLAN WASTEWATER TREATMENT PLANT PLANNING STUDY TOWN OF HINESBURG HINESBURG VERMONT	DESIGNED WAE DRAWN JEN CHECKED (PM) WAE CHECKED (PE) WAE SCALE AS NOTED DATE JULY, 2016	PROJECT NO. 15063 FIGURE NO. 2

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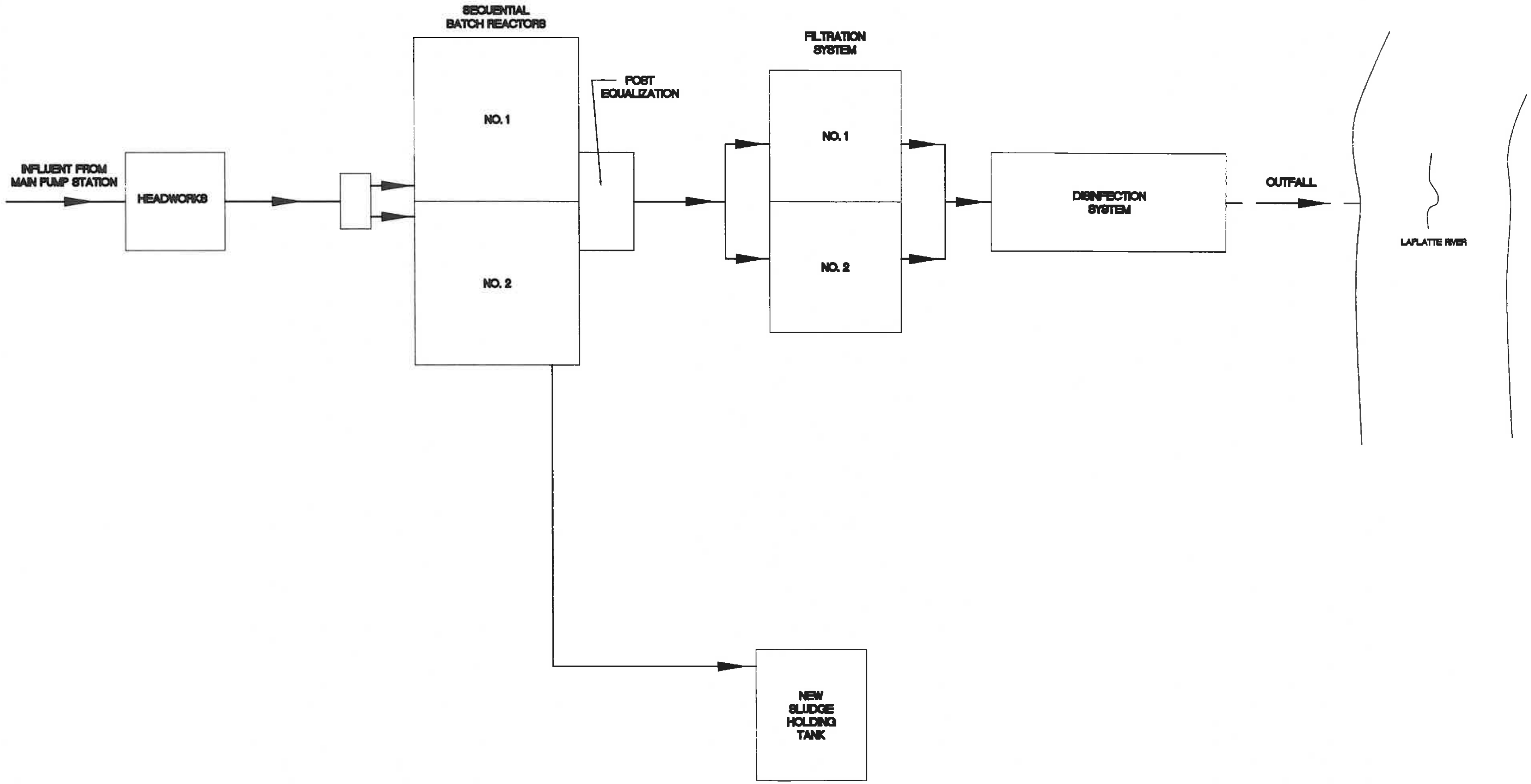

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AEengineers.com

WASTEWATER TREATMENT FACILITY PROCESS FLOW SCHEMATIC

WASTEWATER TREATMENT PLANT PLANNING STUDY

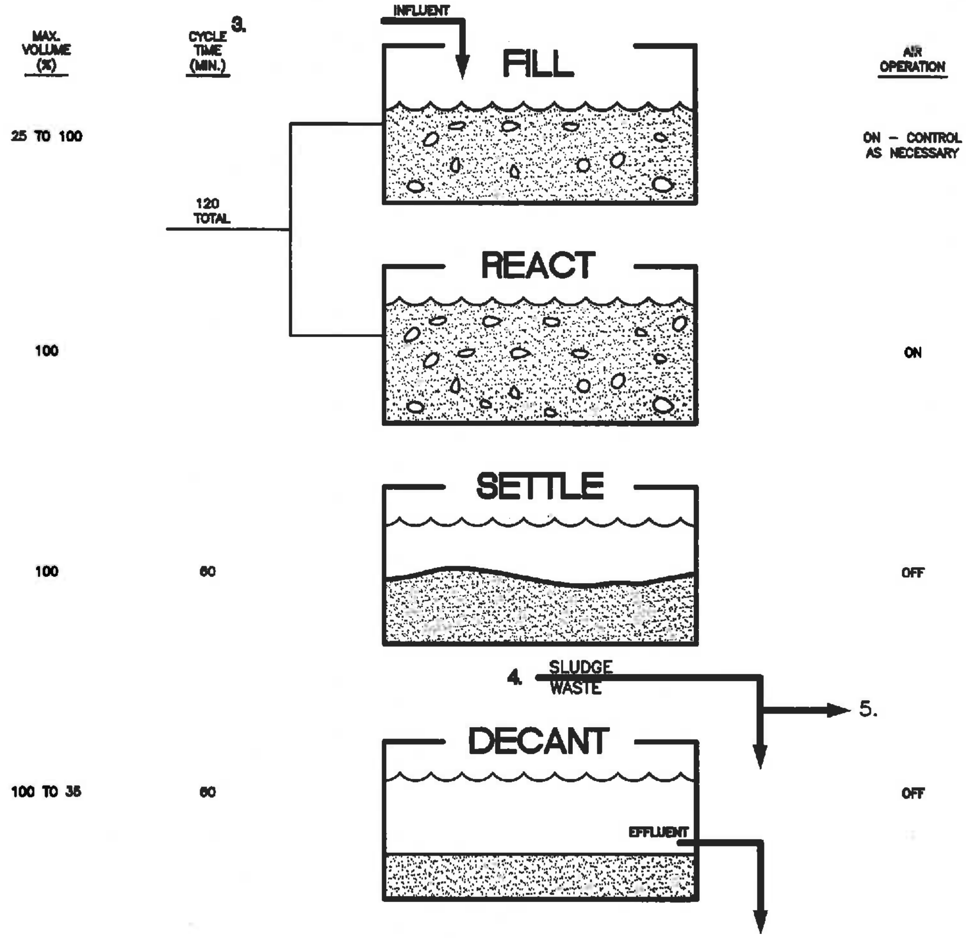
TOWN OF HINESBURG

HINESBURG VERMONT

DESIGNED	WAE
DRAWN	JEN
CHECKED (PM)	WAE
CHECKED (PE)	WAE
SCALE	AS NOTED
DATE	JULY, 2016
PROJECT NO.	15063
FIGURE NO.	3

Y:\15063-HINESBURG\15063-3.dwg, 7/11/2016 2:57:11 PM

SEQUENTIAL BATCH REACTORS
TYPICAL SBR OPERATIONS [1]
NORMAL CYCLE [2]



1. AN SBR TREATMENT SYSTEM HAS A MINIMUM OF TWO REACTION BASINS. EACH BASIN OPERATES ON AN ALTERNATING SEQUENCE FROM THE OTHER BASIN. AS ONE BASIN IS IN THE FILL/REACT CYCLES, THE OTHER BASIN IS IN THE SETTLE/DECANT CYCLES.
   a. THE AUTOMATIC OPERATIONS OF THE SBR CYCLES ARE CONTROLLED BY A PROGRAMABLE LOGIC CONTROLLER (PLC) BASED COMPUTER SYSTEM. THIS SYSTEM FOLLOWS THE SPECIFIC CONTROL LOGIC DEVELOPED BY THE SELECTED SBR MANUFACTURER.
2. THE STORM CYCLE HAS SHORTER CYCLE TIMES.
3. CYCLE TIMES ARE ADJUSTABLE BY THE OPERATOR.
4. SLUDGE WASTING DOES NOT OCCUR DURING EVERY CYCLE. THE OPERATOR CAN ALSO WASTE SLUDGE AFTER THE DECANT CYCLE AS WELL AS AFTER THE SETTLE CYCLE.

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SBR TREATMENT SYSTEM TYPICAL OPERATIONS	DESIGNED WAE	PROJECT NO. 15063
WASTEWATER TREATMENT PLANT PLANNING STUDY	DRAWN JEN	
TOWN OF HINESBURG	CHECKED (PM) WAE	
HINESBURG VERMONT	CHECKED (PE) WAE	FIGURE NO. 4
	SCALE AS NOTED	
	DATE JULY, 2016	

Aldrich + Elliott
WATER RESOURCE ENGINEERS

APPENDIX B

Memo on Reserve Capacity

Department of Buildings and Facilities
Town of Hinesburg
10632 Rte 116
Hinesburg, VT 05461
www.hinesburg.org
hinesburgpw@hinesburg.org
802.482.2096x229

Memo

To: Selectboard

From: Rocky Martin
Buildings and Facilities Director

Date: May 26, 2015

RE: Annual Uncommitted Wastewater Reserve Capacity

CC: Trevor Lashua, Erik Bailey, Art Garrison

Every year we take a look at how much capacity is left at the wastewater plant and apply it by formula to Residential, Enterprise/Commercial and Institutional categories. Attached is this year's report. Our plant is permitted to discharge 250,000 gallons per day (gpd); from 5/1/2014 to 4/30/2015 our average flow was 140,417 gallons per day. This leaves 109,583 gpd capacity available. We have already allocated 14,210 gpd for future Residential projects, 2,920 gpd for future Enterprise/Commercial projects and currently there are no Institutional allocations. Total of all approved allocations or Committed Reserve Capacity is 17,130 gpd. This leaves 92,453 as Uncommitted Reserve Capacity.

Per our Allocation Ordinance, we reserve:

1. 5,000 gpd for Institutional projects- schools, hospitals, municipal etc.
2. 10,000 gpd for the former Saputo property
3. 5,000 gpd for properties within the Existing Village Core

By subtracting the 20,000 gpd listed above from our Uncommitted Reserve it leaves 72,453 gpd; 70% of this is reserved for Residential or 50,717 gpd and 30% of this is reserved for Enterprise/Commercial or 21,736 gpd.

Recommendation and suggested motion:

Move that the Selectboard adopt the Town of Hinesburg Wastewater Treatment Facility Uncommitted Reserve Capacity Report for FY 15-16 as prepared by RMartin and dated 5/26/2015.

Town of Hinesburg Wastewater Treatment Facility

Uncommitted Reserve Capacity report for FY 15-16

All figures in Gallons per Day

Permitted Wastewater Flow			250,000
Plant Wastewater Flow (5/1/2014 through 4/30/2015)			140,417
		Reserve Capacity	**109,583**
Less approved Allocations			
Residential	Expires		
Blomstrann (3 SFR units + Inf on NRG parcel)	6/30/15	830	
Green St LLC (22 units +Inf.)	6/30/17	5400	
Hinesburg Hillside/Thistle Hill (1 lot left)	6/30/17	210	
Marie Aube Smith (1 SFR)	6/30/15	210	
South Farm Homes (2 units)	6/30/17	420	
Norris (24 unit)	6/30/18	5040	
KB Real Estate@ 10004 Rte 116 (2 units)	6/30/15	420	
Brad Wainer 1SFR and Apt	6/30/17	420	
Lawerence and Cynthia Carron	6/30/16	420	
Robert Therrien	6/30/18	210	
Hines Center- Grabowski Lot 48 3 units	6/30/18	630	
	Total Approved Residential Allocations		14,210
Enterprise/Commercial			
Commerce Park/Act 250 approved Lot 15		200	
Green St LLC (1 building w/24 employees)	6/30/17	360	
Martins Foods- Hannafords	2/27/16	2240	
Hines Center- Grabowski Lot 48	6/30/18	120	
	Total Approved Enterprise/Commercial Allocations		2,920
Institutional			
	Total Approved Institutional Allocations		0
Total Committed Reserve Capacity			**17,130**
Uncommitted Reserve Capacity For FY 15-16			**92,453**
a)Institiutional Reserve Capacity (per Allocation Ordinance 8/16/2010)			**5,000**
b)Saputo property Reserve, Tax Map # 20-5-66.000 (per Allocation Ordinance 8/16/2010)			**10,000**
c)Properties within "Existing Village Core" (per Allocation Ordinance 8/16/2010)			**5,000**
Residential Capacity For FY 15-16 (70% of Uncommitted Reserve minus a), b) and c) above)			**50,717**
Enterprise Capacity for FY 15-16(30% of Uncommitted Reserve minus a), b) and c) above)			**21,736**

Town of Hinesburg Wastewater Treatment Plant

	IN		OUT							
Month Year	Inf Avg GPD	Inf Max GPD	Eff Avg GPD	Eff Avg BOD mg/l	Eff Avg TSS mg/l	Eff Avg Phos mg/l	EFF Phos Pounds/Month	Eff Avg UOD lbs/Day	Eff Avg Ammonia mg/l	
May 2014	155,000	237,000	166,000	4.8	5.5	0.30	12.86			
June 2014	129,000	243,000	121,000	6.6	9.0	0.23	6.96	35.88	4.10	
July 2014	106,000	220,000	138,000	5.8	5.0	0.20	7.14	31.06	3.95	
Aug 2014	112,000	169,000	91,000	6.5	6.0	0.20	4.72	31.75	6.10	
Sept 2014	95,000	108,000	186,000	5.7	4.0	0.33	11.75	33.1	10.25	
Oct 2014	123,000	188,000	166,000	3.2	3.5	0.10	10.06			Sludge Removal 2&4
Nov 2014	120,000	162,000	57,000	2.0	3.0	0.03	0.43			No flow 17 days
Dec 2014	169,000	393,000	184,000	2.0	4.0	0.08	3.68			
Jan 2015	112,000	147,000	156,000	5.4	10.0	0.33	13.32			
Feb 2015	90,000	99,000	94,000	3.4	9.5	0.31	6.83			
March 2015	125,000	288,000	146,000	10.9	11.0	0.68	25.72			
April 2015	181,000	378,000	180,000	4.8	12.0	0.50	22.48			
Permit Limts/Standa			250,000	30 mg/l	45 mg/l	.8 mg/l		400 lbs/day	5.96 mg/l	
Avg 5-1-14 to 4-30-15			140,417	5.09	6.88	0.27	125.95	Total Pounds Phos		

Notes: UOD and Ammonia sampled/tested June, July August and September
Currently Phos limit is 0.8 mg/l (milligrams per liter) per month- Current TMDL proposal would go to .2 mg/l (may be applied monthly)
Currently Phos limit is 608 lbs/year; TMDL proposal woould go to 152 lbs/year
AND TMDL proposal contains language that if no significant Phos reduction in Lake Champlain in 3 years (there won't be) they get to apply more stringent
Phos limits on WWTP- Probably would go to .1 mg/l monthly or 76 lbs/year

APPENDIX C

State Letter on Ammonia Discharges

VERMONT

Vermont Department of Environmental Conservation
Watershed Management Division
1 National Life Drive, Main 2
Montpelier VT 05620-3522
www.watershedmanagement.vt.gov

Agency of Natural Resources

[phone] 802-828-1535
[fax] 802-828-1544

Ms. Jennie Auster
Aldrich and Elliot
By electronic mail

02-11-2016

RE: Hinesburg Wastewater Treatment Facility

Dear Ms. Auster,

In response to the Hinesburg WWTF capacity increase meeting on February 8th, 2016, I am providing additional information on ammonia discharges and Water Quality Standards. Under the WQS, two ammonia criteria apply – chronic and acute – which are based on temperature, pH and stream flow. At the WWTF's current operating parameters, ammonia discharges ranged from 4.7 to 12 mg/L total ammonia nitrogen (TAN) during the June to September 2015 monitoring period.

Using the maximum ammonia concentration observed during this period, the receiving water concentration (RWC) at 7Q10 instream waste concentration (IWC) of 55.4% would be 6.5 mg TAN/L (7Q10 IWC 0.554 X 12 mg TAN/L). Monitoring data indicates the pH of the LaPlatte River within this reach is 7.6 (range 7.4-7.87), using the temperature and pH dependent values provided in Tables 5a,b and 6 within the 2013 EPA Ammonia Criteria we find that a value of 6.5 mg TAN/L exceeds the chronic criteria for all temperatures. The acute criteria (Oncorhynchus spp. present) will be exceeded when the temperature is greater than 22°C.

Proposed design flow increases of 0.308 MGD and 0.450 MGD would result in 7Q10 IWC of 0.65 and 0.73 respectively. Using the maximum TAN value of 12 mg TAN/L observed during the 2015 effluent monitoring would result in RWC of 7.8 and 8.7 mg TAN/L respectively. At these conditions the chronic criteria will still be exceeded at all temperatures and the acute criteria will now be exceeded when temperatures are greater than 20°C and 19°C respectively.

The June to September 2015 monitoring period provided data for the warm weather periods, however in cold weather, effluent is expected to be significantly higher in ammonia, and monitoring will capture much higher levels, likely 2–3X higher than the 12 mg TAN/L. For illustrative purposes, using a hypothetical value of 24 mg TAN/L at current operating parameters would result in a RWC of 13.2 mg TAN/L. This will result in acute criteria exceedances for all temperatures. Using proposed design flow 7Q10 IWC of 0.65 and 0.73 respectively would result in RWC of 15.6 and 17.5 mg TAN/L. These TAN values would also exceed acute criteria for all temperatures.

To ensure that WQS are not exceeded, engineering analysis will need to consider approaches to manage TAN to be in attainment of WQS.

Please let me know if you have any questions.

Sincerely,

Rick Levey, Environmental Scientist
Monitoring, Assessment and Planning Program

Cc: Lynnette Claudon, DEC-FED
Ernie Kelley, WSMD-WW
Neil Kamman, WSMD-MAPP
Wayne Elliott, Aldrich + Elliott

APPENDIX D

Lemna LemTec Lagoon Upgrade Proposal

LemTec™ Biological Treatment Process

Lemna Environmental Technologies

L•E•T

Treating Your Water Right

Proposal For: Hinesgurg, VT Lagoon Upgrade

Prepared for: Wayne A. Elliott, PE
Aldrich + Elliott, PC

Prepared by: Jim Martin
President
LET

Proposal Number: 1468
Revision Number: 1
March 7, 2016

INTRODUCTION

Thank you for including the LemTec™ Biological Treatment Process (LBTP) in the planning of the treatment facility of Hinesburg, VT. Based on the information provided, we have revised our preliminary design and budget estimate for this project. The objective of our proposed system is to provide the best possible biological treatment solution capable of meeting or exceeding your requirements in the most efficient and cost effective way possible.

This revised proposal has been prepared for Mr. Wayne Elliott, who is currently evaluating treatment alternatives for the Town, and is interested in products/technologies that can provide improvements to the existing facility, in order to accommodate projected flows as well as meet BOD, TSS, ammonia and phosphorus limits.

Lemna Environmental Technologies' proposed process design is based upon the following design parameters and site data.

DESIGN PARAMETERS

	Influent Summer	Influent Winter		Effluent Summer	Effluent Winter	
Flow	0.308	0.308	MGD			
$CBOD_5$	190	190	mg/L	24.5	24.5	mg/L
TSS	190	190	mg/L	36.5	36.5	mg/L
Ammonia	25	25	mg/L	5	5	mg/L
Nitrogen	-	-	mg/L	-	-	mg/L
Phosphorus	6	6	mg/L	0.8	0.8	mg/L

The proposed LBTP design described below will achieve the basic requirements and provide a number of advantages to the end user which are unmatched by alternative technologies. The patented LBTP is an effective, reliable, and affordable aerated lagoon based biological treatment process which utilizes a series of aerobic treatment cells followed by a settling zone and a polishing reactor. The LemTec™ process is capable of achieving year-round effluent limits of 20 mg/l BOD, 20 mg/l TSS, less than 1 mg/l NH_3 and 0.8 mg/l P at a fraction of the cost of other traditional wastewater treatment systems. With a reduced footprint, a process that is extremely reliable, and simple to operate, the LBTP is the highest performance lagoon-based package in the world and offers numerous advantages over other systems, including lower capital and operating costs, expandability and low maintenance.

TOWN OF HINESBURG DESIGN OVERVIEW

The proposed design will utilizes two of the existing four lagoons with depths of 10' to handle a total design flow of .308 MGD. Following the treatment lagoons, a Lemna Polishing Reactor will provide additional BOD, TSS and ammonia treatment. In addition, phosphorus removal is included in this design.

The first lagoon will be divided into three cells using Lemna's custom designed LemTec™ Reverse Miter Hydraulic, which will be installed to minimize short-circuiting between each cell. The first cell will be a complete mix cell utilizing high rate diffusers. The existing aeration system will be modified and updated to achieve optimal oxygen transfer and mixing.

The complete mix zone of the LBTP process is an aerated, aggressively mixed cell that establishes an environment suitable for the rapid removal of BOD_5 by heterotrophic bacteria. The reduction of BOD_5 is calculated using state-of-the-art "mechanistic" models that relate to the growth of bacteria and removal of BOD_5 in relation to detention time and wastewater temperature. Similar models are currently used for the design of activated sludge plants.

In addition to BOD_5 removal, ammonia is also removed by heterotrophic bacteria present in the complete mix cell. Ammonia is utilized by the bacteria to support its nitrogen requirement for growth. Also, nitrifier growth will occur in the complete mix cell resulting in additional (and significant) ammonia reduction.

Following the complete mix cell, water will flow into two partial mix cells utilizing low rate diffusers. Partial mix cells require lower levels of aeration and mixing in order to effectively achieve BOD_5 removal. Using low rate diffusers, air will be introduced to maintain optimal degradation of BOD_5. Mixing will also economically occur in order to achieve effective biological reaction rates and to maintain partial suspension of solids.

The second lagoon will serve as a settling pond with a detention time of 9.2 days. In order to ensure effective ammonia removal, all the lagoon cells in the proposed design will be covered by Lemna's LemTec™ Modular Insulated Cover rated at R10. The LemTec™ Cover prevents algae growth by eliminating sunlight below the cover and improves clarification in two ways: 1) it prevents wind action on the water surface thereby establishing a quiescent zone for solids to settle, and 2) the insulation minimizes seasonal and diurnal temperature fluctuations, thereby reducing stirring by thermal currents. The LemTec™ Cover improves TSS removal, provides algae prevention and encourages nitrification by regulating temperatures within the ponds.

Phosphorus removal in the LemTec™ system is achieved by chemical addition within a rapid mixing chamber and flocculation in the settling cell of the treatment lagoon. LET recommends the use of Alum or Ferric Chloride as the chemicals for precipitating phosphorus. Chemical dosage and sludge accumulation rates vary with site conditions. Mixers, chemical storage and dosage system are sized and supplied by LET.

For the purposes of our design, the phosphorus removal chemical dosing system will be located between the aerated treatment lagoon and the settling pond. The chemical feed system will supply chemical to a rapid mix zone equipped with a 2.5 HP mixer.

After the rapid mix zone, effluent will flow into one corner of the final settling pond, which will be a baffled flocculation zone equipped with a 2.0 HP floating mixer. Following the phosphorus removal and settling, flow will enter The LemTec™ Polishing Reactor (LPR) for final BOD and ammonia polishing.

The LemTec™ Polishing Reactor (LPR) will provide additional BOD and ammonia treatment. The LemTec™ LPR consists of submerged, attached-growth media modules used for maintaining an adequate population of bacteria. The LPR enhances the growth of nitrification bacteria to encourage conversion of ammonia to nitrates in an aerobic environment. Aeration is provided by rack-mounted coarse-bubble diffusers located under the media, which evenly distribute the air and shear coarse bubbles into very fine bubbles. The LPR produces BOD and TSS effluent levels less than 10 mg/l and NH_3-N lower than 1 mg/l. Typically housed in a concrete or metal structure near the effluent of the pond, the LPR is the final stage of the lagoon based LemTec Biological Treatment Process. The approximate size of the proposed LPR for this option is 16'48'12'.

The oxygen requirements for this option will be met (3) 20 HP blowers, of which 2 will be in continuous operation. A schematic of the proposed design is attached for your reference.

DESIGN SUMMARY

	Water Depth (ft)	Freeboard (ft)	Slope	Waterline Length (ft)	Waterline Width (ft)	Volume (MG)	Detention Time (days)
Basin # 1	10	3	2.5	410	185	4.6	14.8
Basin # 3B	10	3	2.5	280	175	2.8	9.2

	Mixing	Detention Time (days)	Winter Temp. (C)
Cell 1A	CM	3.0	9.7
Cell 1B	PM	5.9	9.2
Cell 1C	PM	5.9	8.7
Cell 3B	SC	9.2	7.9

A summary of the equipment supplied is provided in the table below:

EQUIPMENT SUMMARY

	Cover	Baffle		Existing Blower		Cubes	Existing Diffusers
	Sq. Ft.	Qty.	Ft.	Qty.	HP	6'x6'x8'	Units
Aeration Pond	75,850	2	189	3	20		
Complete Mix							40
Partial Mix							19
Partial Mix							16
Settling Pond	49,000						0
LPR	675					11	1

Phosphorus Removal System:
Storage tank: 1500 gal
Rapid mixing mixer: 2.5 HP
Flocculation zone mixer: 2 HP
Feed pump capacity: 2.1 gal/hr

DESIGN LAYOUT/DRAWINGS

Layout drawings are attached.

LET PROJECT SUPPLY SCOPE

Engineering/Technical Services
- Lemna System Design Recommendations
- Lemna System Equipment Details
- Lemna System Plans and Specifications
- Lemna Design Calculations
- Regulatory Technical Support

Equipment Supply
- LemTec™ Insulated Cover
- LemTec™ Aeration System
- LemTec™ Polishing Reactor

Installation/Start-Up/Training

Equipment Installation Supervision (Lemna Equip.)
Process Start-Up/Training (Lemna Process)
Ongoing Technical Support

By others: Civil Design, Electrical Design, Mechanical Design, Other Design Services (if required). Pond De-Sludging, Site Work/Improvements, Concrete Structures, Yard Piping (out of basin),Electrical Service to Site, Interconnect Wiring (Equipment to Equipment/ Remote Disconnect/MCCs/Control Panels).

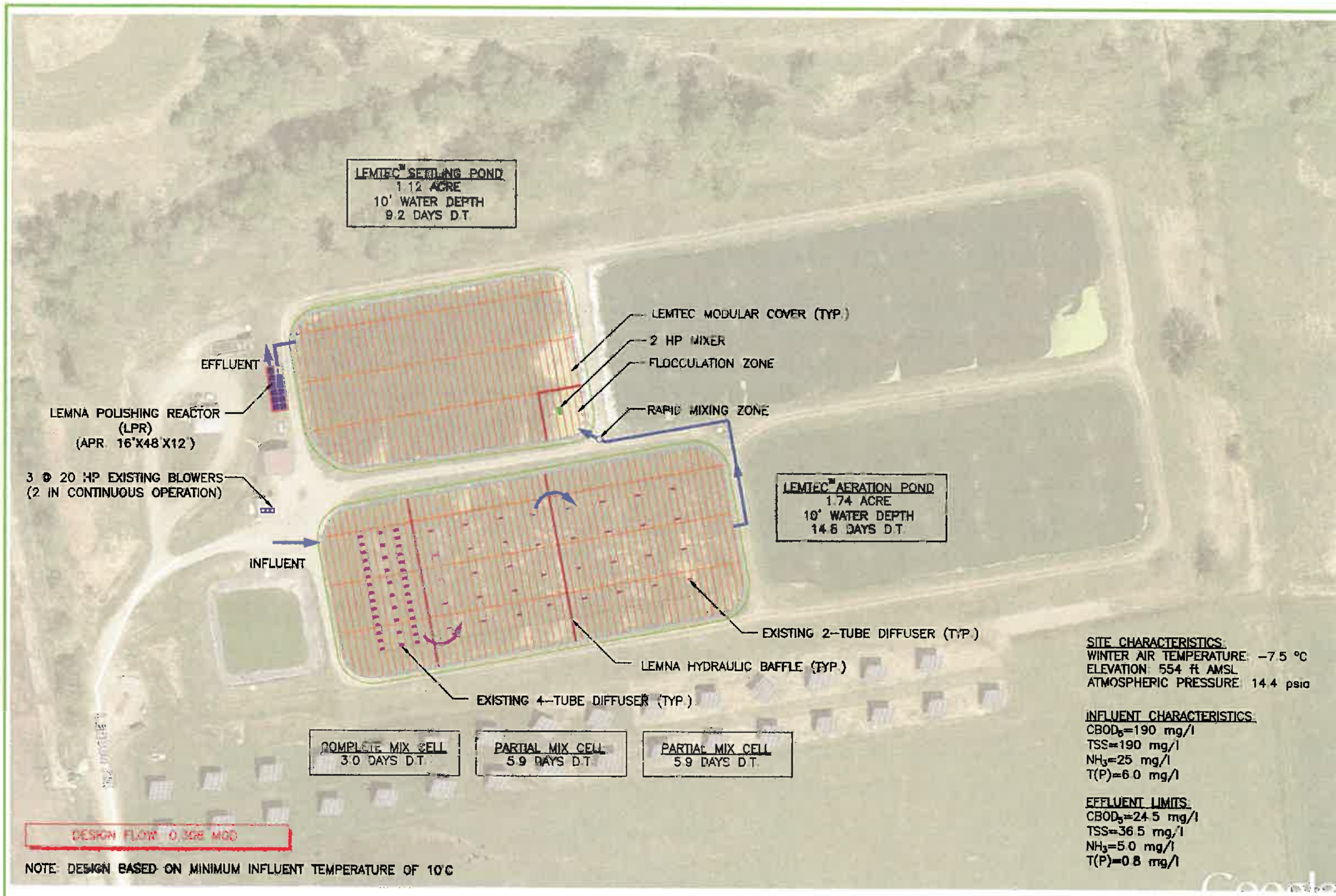
LET PROJECT PRICING

Equipment/Services Equipment Freight (estimate)	$580,922 $ 56,578
Total Proposed Price	**$637,500**

Proposed pricing is based on available information and is valid for 60 days. Prices are in US funds and do not include any applicable taxes. All sales are subject to LET's standard terms and conditions. Proposed price subject to change based on changes in final design and final scope at time of bid or based on size changes at time of final survey. Typical equipment lead time is 6-12 weeks after approval of final submittals. Equipment lead time is subject to change based on size of project, complexity of design, customer requirements and shop-loading at time of order.

LIMITED WARRANTY

All LET supplied components are warranted against manufacturer's defects for a period of twelve months. This warranty does not cover wear or damage caused by improper installation, operation or maintenance. In the event of a manufacturer's defect, Lemna will repair or replace the damaged component. A process warranty based on the design parameters included as part of this proposal. This process warranty is contingent upon the full supply by LET of all equipment detailed in this proposal.



THIS DESIGN IS PROPRIETARY TO LEMNA ENVIRONMENTAL TECHNOLOGIES, INC. AND IS SOLELY INTENDED FOR APPLICATION AT HINESBURG, VT BY LEMNA ENVIRONMENTAL TECHNOLOGIES, INC. THIS DESIGN CANNOT BE USED BY A THIRD PARTY NOR REPRODUCED, IN FULL OR IN PART, WITHOUT THE WRITTEN AUTHORIZATION OF LEMNA TECHNOLOGIES, INC.

DRAWN BY:	DAP
APPROVED BY:	JAN
SCALE:	NOT TO SCALE
DATE:	MARCH 2016
SHEET NO:	1 OF 1

LEMTEC™ BIOLOGICAL TREATMENT PROCESS
HINESBURG, VT

L·E·T
LEMNA ENVIRONMENTAL TECHNOLOGIES, INC.

APPENDIX E

EDI IDEAL Lagoon Upgrade Proposal

The IDEAL® Solution Budgetary Design

Intermittently Decanted Extended Aeration Lagoon (IDEAL) for Advanced Wastewater Treatment for Hinesburg, VT

March 7, 2016

Prepared for:

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Aldrich + Elliott, PC

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Lagoon Solutions

EDI

Proposal: LS-27898-2.1

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I. Wastewater Design Basis

The preliminary EDI IDEAL process proposal has been developed based on the following wastewater influent conditions. Customer to confirm design values for final design and warranty criteria.

A. Influent Wastewater Flow

Parameter	Value	Unit
Design Average Flow	0.308	MGD
Peak Flow*	0.739	MGD

* Estimated value

B. Influent Wastewater Quality

Parameter		Design Value	Unit
Average BOD_5	Concentration	190	mg/L
	Design Load	488	lb/d
Total Suspended Solids	Concentration	190	mg/L
	Design Load	488	lb/d
Total Phosphorous	Concentration	6	mg/L
	Design Load	15.4	lb/day
TKN	Concentration*	30	mg/L
	Design Load*	77	lb/d
Alkalinity	Concentration*	150	mg/L
	Design Load*	386	lb/d

* Estimated value

C. Site Conditions

Parameter	Value	Unit
Operational Water Temperature*:	8/15	°C
Relative Humidity (Summer)*:	65	%
Site Elevation (at berm)*	554	ft

* Estimated Value

D. Target Permit Effluent Concentrations

Parameter (Monthly Average Concentration)		Design Value	Unit
BOD_5		24.5	mg/L
Total Suspended Solids		36.5	mg/L
Total Phosphorous		0.8	mg/L
Ammonia-Nitrogen		10	mg/L
pH		6.5-8.5	

II. Process Selection Details

A. IDEAL Bioreactor Description

The Intermittently Decanted Extended Aeration Lagoon (IDEAL) Solution incorporates an EDI floating or submerged lateral aeration system with premium fine bubble diffusers, chains of BioReef™ BioCurtain™, decanters, process controls, and blowers.

The reliable components of the IDEAL system provide easy, cost-effective operation while providing high levels of BOD, TSS, and ammonia removal. The process is specifically engineered to minimize sludge management. Extremely high flow events are handled routinely with minimum biomass loss. The IDEAL process also provides total nitrogen reduction as part of the basic package, which delivers lowest energy cost. IDEAL is a basic process that can be easily designed to accommodate strict total nitrogen or phosphorous limits and provide state-of-the-art treatment performance.

The ability of the IDEAL Bioreactor to provide front-of-plant treatment provides several benefits over other lagoon-based technologies. By removing ammonia at the front of the plant the system can utilize the influent carbon for denitrification, with oxygen and alkalinity recovery. Simple sludge management is incorporated as the IDEAL Bioreactor retains and maximizes biomass in the first cell for optimal treatment capability by using the entire surface of the bioreactor for clarification/solids separation. A programmed decant of the treated effluent provides superior quality discharge.

A unique advantage of the IDEAL process is the ability to treat high surge flows through the system without having significant impact on biomass concentration or post-surge treatment capability. The IDEAL's unique combination of suspended growth activated sludge plus attached growth biomass minimizes washout and avoids system overload. The entire IDEAL basin surface is used for solids separation so solids setting happens more effectively than in a smaller, conventional clarifier. Also, since the solids stay in the IDEAL Bioreactor, there is no need for complicated return sludge pumping and solids management.

B. Ancillary Basin Detail

The EDI IDEAL Bioreactor has a great deal of flexibility and can be incorporated into multiple process configurations. The IDEAL can be designed to meet maximum levels of biological treatment and enhanced levels of nutrient removal with the use of side-stream sludge management, process oxygen control, and/or tertiary filtration. Likewise, the basic IDEAL process can take advantage of lagoon simplicity and provide an excellent quality of water with minimal operator oversight and system control requirements.

The ammonia limits at Hinesburg are relatively high (10 mg/L). EID has been developing the IDEAL to meet ammonia limits of <1 mg/L throughout the year, and have collected extensive data on ammonia removal and rebound in the most basic configuration utilizing downstream lagoon –based sludge storage (Figure 1).

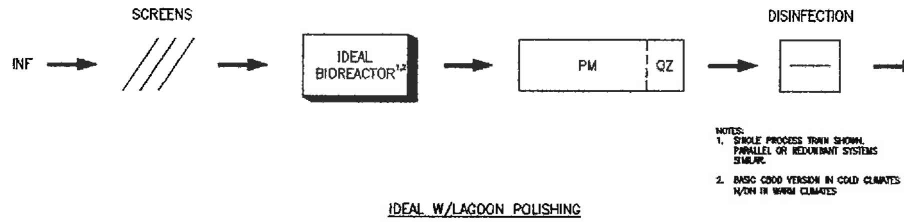

Figure 1. IDEAL Bioreactor with Lagoon Polishing

The IDEAL Bioreactors that have been in long-term operation utilizing the configuration seen in Figure 1 have not experienced ammonia-nitrogen concentrations greater than 5 mg/L during the spring rebound cycle. Should future regulations demand increased effluent quality, then a system upgrade to the configuration shown in Figure 2 could help meet ammonia-nitrogen less than 1 mg/L year-round, a total nitrogen concentration of 10 mg/L, and a total phosphorous concentration of less than 0.5 mg/L.

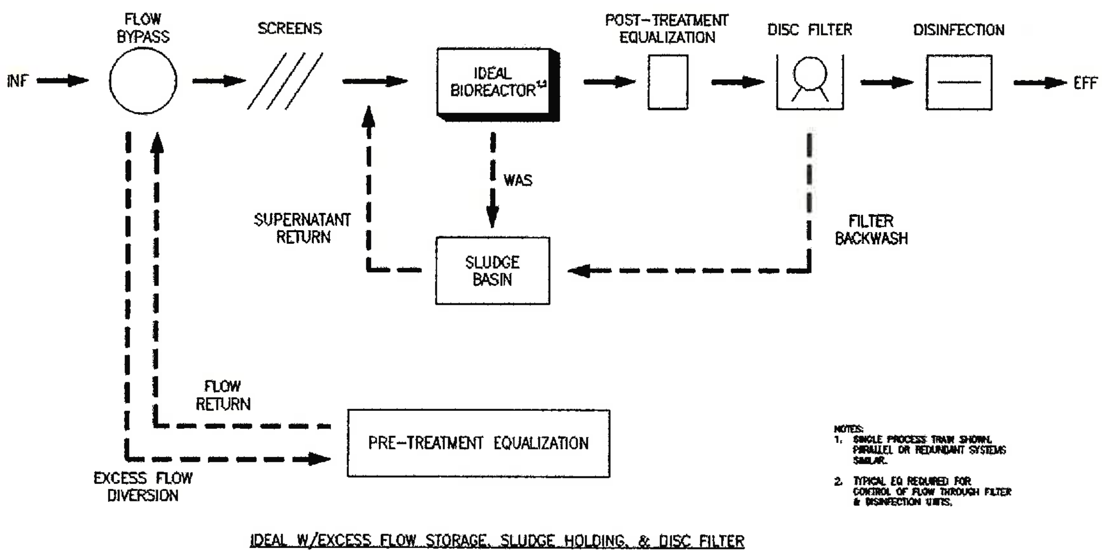

Figure 2. IDEAL Bioreactor with Side-Stream Sludge Wasting, Post-Treatment EQ, and Optional Disc Filtration

The IDEAL is able to produce a very high quality of water without the need for post-treatment polishing. Therefore, direct discharge from the IDEAL Bioreactor reactor may be preferred for the simplicity and affordability of the basic system. If disinfection or a steady effluent flow is required then EDI recommends the use of a post-treatment equalization basin. Either of these selections requires the use of a side-stream sludge digestion and holding basin (Figure 2). Flow equalization is needed prior to disc filtration.

Post-Treatment Flow Equalization and Optional Disc Filtration

The IDEAL Bioreactor is a constant inflow, batch outflow process, similar to many sequencing batch reactors. The result is a high level of treatment and four hours of water flow released over the course of an hour during normal operation (this may change depending on site-by-site operational selections). A post-treatment equalization basin provides the system with a means to normalize water flow after treatment in the IDEAL and can reduce the size of disinfection equipment or other downstream process.

The post-treatment EQ basin can be constructed as a lined earthen basin or as a concrete tank. EDI provides general sizing recommendations for this basin. Once water from the IDEAL enters this basin it can either gravity-flow out of the basin, provided adequate hydraulic grade, or it can be pumped to downstream processes.

Disc filtration is recommended for maximum removal of TSS, BOD, and/or total phosphorus. The EDI Disc Filter is superior in its simplistic design and operation. Unlike many filters on the market today, the EDI Disc Filter uses removable filter sections that are backwashed by a moving arm. This results in highly economical installation and maintenance compared to those filters that rotate the entire filter system for the backwash function. Although it may not be needed today, EDI highly recommends planning for eventual installation of a filter to accommodate future phosphorous regulations.

Sludge Digestion Basin

For any high rate and efficient biological process excess bio-solids will be generated and must be managed. For extended aeration, conventional activated sludge or the EDI-IDEAL™ advanced wastewater treatment process, excess solids must generally be removed from the biological reactor, concentrated, digested, and then disposed. Traditional lagoon-based systems are designed to retain solids within the treatment basins. Complete Mix (CM) lagoons are followed by Partial Mix (PM) lagoons, which serve as the digester or sludge storage and management for the system.

A lagoon digester can be effective use of existing infrastructure. The lagoon digester can be aerobic, facultative, or anaerobic, depending on the goals of the owner and/or engineer. Note a concrete digester structure can be effective in stabilizing the sludge as well, with solids disposed to land application or other process.

The IDEAL Bioreactor is modeled using a controlled sludge age to provide adequate design of sludge wasting pumps and related components. Sludge wasted form the IDEAL is directed to the digester for stabilization and reduction. The digester should incorporate an overflow or small settling zone so that supernatant can flow back and mixed with influent to the IDEAL for reprocessing. The frequency of solids disposal depends on the size and nature of the digester.

C. Existing Infrastructure and Construction

The IDEAL Bioreactor by EDI provides a great deal of flexibility during planning and construction, as well as during operation. The "front-of-the-plant" treatment philosophy is achieved by concentrating biomass, and allows the reactor to be relatively small compared to other options. Furthermore, the front-of-the-plant configuration provides easy, modular upgrade for advanced TN and TP removal.

Figure 3 shows one potential layout for the first phase. The IDEAL is constructed in Pond 1 with the process configuration represented in Figure 1 referenced in the previous section. The remaining volume in Cell 1 can be used for pre-treatment flow equalization or the cell can be abandoned. Coagulant can be added in the current location (i.e., between pond 3a and 3b) or can be injected directly into the IDEAL. Waste sludge from the IDEAL is conveyed downstream through the decanters to the partial mix pond where it undergoes digestion. This configuration will provide an effluent ammonia concentration of <10 mg/L year-round and minimize treatment plant operation and control.

Figure 3. Example Layout to Show Proportions and Basins

Figure 4 shows a potential Phase 2 IDEAL configuration where the process is based on the diagram seen in Figure 2. This configuration may or may not include pre-treatment flow equalization. It is designed to meet a year-round ammonia of <1 mg/L and can easily reach an effluent total nitrogen concentration of <10 mg/L. This configuration will waste sludge via centrifugal (or similar) pump to the current waste sludge cell and, as such, will provide more reliable total phosphorous removal via biological assimilation (2-4 mg/L).

Figure 4. Example Layout to Show Proportions and Basins

Please keep in mind that these configurations are only tentative. The IDEAL can be situated in a number of different ways to help minimize overall project cost. Working through that value-added exercise represents an excellent opportunity for collaboration between Aldrich + Elliott, David Sullivan & Assoc., and EDI.

EDI's Aeration Works division specializes in lagoon retrofits. We invite you to engage them prior to construction planning for additional input including staging, planning, and budgeting.

D. Optional EDI Installation, Warranty, and Service Programs

Aeration Works Installation

EDI Aeration Works™ division was created to give contractors and operators of aeration systems a source for fast, reliable installation and maintenance. The EDI Aeration Works group is made up of experienced installers and field service professionals. Aeration Works personnel are experts at the installation and maintenance of aeration systems with process and operational optimization objectives.

Aeration Works (AW) expert installers are faster and more thorough than someone new to installing in-basin IDEAL components including decanters, BioReef, and EDI aeration systems. AW experts know what tools are needed, how to perform installations quickly, and how to ensure it is done exactly to manufacturer's specifications. Utilizing Aeration Works' expertise for system installation ensures the job is done right.

Benefits of planning for Aeration Works installation include:

- Mechanical warranty against defects and workmanship increases from 2 to 5 years.
- Eliminates inspection requirements for validation of process warranty.
- Project completed more quickly with seamless communication and familiarity between installation crew and manufacturer.
- Decreased contractor administrative duties (inspection scheduling, inventory, subcontractor scheduling, etc.)
- Single-point responsibility should any future issues arise.

Preventative Maintenance Program

For maintenance or preventative maintenance, the Aeration Works group has the experience to evaluate the degree of work needed then properly refurbish a system for maximum long term performance. When construction crews or contractors have already been selected, Aeration Works can also provide supervision to assure the work is done to manufacturer's specification.

A maintenance plan allows facility operators to outsource scheduled maintenance of their aeration systems to EDI Aeration Works group. When this program is chosen as part of a new IDEAL Process sale, the mechanical warranty of the aeration system is extended as long as a service agreement is in place. Aeration Works can inspect any existing aeration or treatment system and a preventative maintenance program can be developed. The benefits of a preventative maintenance plan include:

- Minimizing unscheduled outages
- Easy budgeting with a single annual expense to cover all parts and labor
- Increased energy efficiency and savings
- Decreased operating costs

Infinity Program™

This program incorporates the mechanical warranty and services of the Preventative Maintenance Program but goes one step further by guaranteeing the performance of the aeration system. Under this program, EDI maintains the physical condition of the membranes through preventative maintenance procedures and will periodically measure the performance of the membrane. Aeration Works will replace or adjust the equipment to ensure the aeration system operates within a pre-determined performance envelope.

III. Preliminary System Components Selection

A. Checklist and Description:

One (1) IDEAL Bioreactor

		YES	Not Required	By Others
A.	Headworks (3/8" screen)	☐	☐	☑
B.	Premium Positive Displacement Blower Package	☑	☐	☐
C.	IDEAL Aeration System, Complete	☑	☐	☐
	a. Floating Laterals and Supports			
	b. Retrievable Assemblies and Diffusers			
	c. Purge and Miscellaneous			
D.	BioReef BioCurtain	☑	☐	☐
	a. Influent			
	b. Effluent			
E.	WAS Pumps	☐	☑	☐
F.	Decanters	☑	☐	☐
G.	Influent Manifold	☑	☐	☐
H.	Probes / Bioreactor			
	a. Liquor Level & Storm Mode	☑	☐	☐
I.	Valves			
	a. Decanter Valves and Actuators	☑	☐	☐
J.	Process Controls	☑	☐	☐
	a. Energy-Smart Blower Operation			
	b. ArcArmor™ Tri-Panel System or Similar			
	c. Soft Starters for Blowers			
K.	Engineering Support for IDEAL	☑	☐	☐
L.	Training and Field Service	☑	☐	☐
	a. Documentation and IOM Manuals			
	b. On Site Start Up Support			
	c. On Site Operator Process and Maintenance Training			
	d. Two-Year Onsite Support Package			
M.	Mechanical and Process Warranties	☑	☐	☐
N.	Freight to Site	☑	☐	☐
O.	Optional Extended Maintenance Contract Available	☑	☐	☐

*Available with EDI Package once sizing determined.

B. Budgetary Cost Estimates*

EDI Lagoon Solutions– IDEAL Bioreactor: $_________ U.S.D.

System as described in previous sections.

Includes Extended 2 year Field Service, operator support and training, plus supervision and coordination of monitoring.

Optional Disc Filter: $_________ U.S.D.

EDI Disc Filter comes as drop-in unit with ClearArm™ backwash technology for ease and efficiency of operation.

Ancillary Basins and Equipment – To be selected by engineer and/or customer

*All prices to be reviewed upon confirmation of project scope and hardware specifications. Stated costs are estimates and subject to +/- 10% if no changes to scope and/or specifications are made.

IV. Design Data

IDEAL Bioreactor

A. Influent Wastewater Flow

Parameter	Value	Unit
Design Annual Average Flow:	0.308	MGD
Design Peak Hour Flow:	0.739	MGD

B. Wastewater Influent Quality

Parameter	Value	Unit
BOD concentration	190	mg/L
loading	488	lb/d
TSS concentration	190	mg/L
loading	488	lb/d
NH3-N concentration	19	mg/L
loading	48	lb/d
TKN concentration	30	mg/L
loading	77	lb/d
Alkalinity concentration	150	mg/L
loading	386	lb/d

C. IDEAL Process Effluent Quality

Performance of the IDEAL Process is based on the influent design wastewater quality and the following design criteria:

1. Proper operation and maintenance provided for the IDEAL Bioreactor and Process components.
2. Adequate alkalinity and nutrient concentrations in influent wastewater to allow biological process to proceed properly and completely.
3. Proper solids and/or grit removal provided ahead of IDEAL Bioreactor.
4. Toxic materials, oils, chemicals, metals, or other inhibiting materials are at acceptable levels to allow full biological activity to proceed effectively.

Expected IDEAL Process Effluent

Parameter	mg/L	lb/day
BOD	3.8	10
TSS	7.6	20
NH3-N (Winter)	4.9	12.5
NH3-N (Summer)	3.8	9.9

D. IDEAL BioReactor Design Criteria

Parameter		Value	Unit
Mixed Liquor Suspended Solids		1373	mg/L
f/m		0.04	
SRT @ Design Flow		15.0	days
HRT @ Design Flow		3.3	hours
Operating Water Temperature (Winter)	(Winter)	8	°C
Operating Water Temperature (Winter)	(Summer)	15	°C

E. **Preliminary IDEAL Bioreactor Sizing**

Parameter (per Basin)	Value	Unit
# of Basins	1	
High Water Level, HWL @ Peak Flow	11.0	ft
Side Slope Ratio	2.5:1	(Length:Depth)
Basin Length @ H.W.L.	190	ft
Basin Width @ H.W.L.	105	ft
Basin Length @ floor	135	ft
Basin Width @ floor	50	ft
Freeboard @ Peak	2.0	ft
SOR	1517	lb/d
# of Decanters	2	
# of BioReef Curtains	2	
# of Laterals	10	

G. **Preliminary Power Estimate**

Parameter	Value	Unit/Basin
Number of Duty Blowers	1	
Number of Standby Blowers	1	
Biological Airflow Requirement at Design Flow	1039	scfm
Estimated IDEAL Power Requirement	24	kW
Daily Operational Period	12.00	hours/day
Daily Power Estimate	291.16	kWh/day

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Aldrich + Elliott
WATER RESOURCE ENGINEERS

APPENDIX F

Evoqua Comag Proposal

HINESBURG WWTP
HINESBURG, VT

COMAG™ MP SERIES 1 MGD MODEL CONCEPTUAL PROPOSAL

ALDRICH + ELLIOTT, PC

January 2016

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Evoqua Water Technologies is pleased to present a preliminary CoMag system proposal. The CoMag Treatment System is an innovative and proven technology for the removal of solids, heavy metals and other particulate or precipitated contaminants. The CoMag process is based on conventional coagulation and flocculation, but uses an innovative ballast material which differentiates the process from other technologies. The ballast material is magnetite (Fe_3O_4), which is a fully inert, high specific gravity (5.2), finely ground, non-abrasive, iron ore. Additionally, the magnetite ballast used in the CoMag system is NSF/ANSI 61 certified for use in drinking water applications.

The treatment goal for this facility, in applying the CoMag system, is to

- achieve an effluent phosphorus concentration of 0.11 mg/l

1 DESIGN SUMMARY

Table 1 summarizes the design basis for the proposed CoMag system.

Table 1: Design Basis.

Parameter	Units	Design
Design Average Daily Flow	MGD	0.45
Design Peak Hourly Flow	MGD	1.08
Design Average Daily Influent Total Phosphorus	mg/L	<5

Table 2 summarizes the effluent performance used as the basis for the proposed CoMag system.

Table 2: Effluent Performance.

Parameter	Units	Design
Average Monthly Effluent Total Phosphorus	mg/L	0.11

Table 3 summarizes the preliminary process configuration for the proposed CoMag system.

Table 3: Preliminary Process Configuration.

Parameter	Design
Number of Treatment Trains	1
Coagulation Reaction Tank (T-1) Dimensions	7′ × 7′ × 11′ SWD
Ballast Reaction Tank (T-2) Dimensions	3.5′ × 7′ × 10.67′ SWD

Parameter	Design
Polymer Reaction Tank (T-3) Dimensions	3.5′ × 7′ × 10.67′ SWD
Clarifier Type	Squircle with Lamella Tube Settler
Clarifier Dimensions	7′ × 7′ × 9.34′ SWD

2 COMAG OPERATING COSTS

The estimated operation and maintenance requirements listed below are based on past experience at other CoMag installations. Project specific O&M requirements will be defined after completion of jar testing and/or a comprehensive pilot testing program. The quantities listed herein are estimates and do not represent a warranty or guarantee. The actual requirements might differ due to differences in the influent wastewater characteristics and the manner by which the system is operated.

2.1 Electrical Loads and Chemical Use

As guidance and reference, Table 4 lists the main consumables associated with the CoMag system recommended for this project.

Table 4: Estimated CoMag Consumables.

Item	Guidance
Daily magnetite usage	~ 9-25 lb per MGD treated
Power usage of CoMag equipment	8 bHP per train
Polymer – as dry active	0.5 – 1.0 mg/L
Coagulant (iron or aluminum)	
Ferric Chloride (40%)	8 – 20 mg/L as Fe
Alum (48.5%)	3 – 9 mg/L as Al
Caustic (pH adjustment)[1]	Varies

2.2 Sludge

The amount of waste sludge produced by the CoMag system will vary based on specific operating conditions such as influent solids load, coagulant type and coagulant dose. As guidance and reference, Table 5 lists a range of estimated sludge production for the coagulant doses listed in Table 4.

[1] Caustic dose depends on the alkalinity in the influent wastewater, the treatment goals, and the operating pH. It varies significantly, with some plants needing little or none and other plants needing more.

Table 5: Sludge Production.

Coagulant	Sludge Production
Alum	200 – 250 lb/d
Ferric Chloride	200 – 325 lb/d

3 FUTURE DESIGN EVALUATION NEEDS

The following design features will need to be evaluated and discussed in more detail as the CoMag design progresses:

- Peak flow duration
- Chemical feed system; chemical preference
- Coagulant addition and dispersion method
- Upstream unit operation
- Plant hydraulics

4 SCOPE OF SUPPLY

The MP (Modular Plant) pre-engineered CoMag system is an ultra-compact, fully functional, and operator-friendly packaged system that saves time and money. Modular designs permit combinations of units for higher treatment capacity and future limit restrictions. Minimal civil requirements allow for quick installation of the CoMag MP system. A pre-fabricated, painted carbon steel tank assembly ships to the site and is placed on a concrete slab. Due to shipping size restrictions, equipment/materials such as the drum separator, pump, mixers, electrical control panel, and railing are shipped separately to be installed by the contractor. A rendering of the fully assembled CoMag MP system is located in the appendix.

When comparing the relative value of CoMag to other systems we strongly encourage evaluation of the fully installed and fully operational economics of CoMag and its competitors. We often find at this stage of the evaluation, differences in scope of supply between CoMag and its competitors can significantly influence cost comparisons. Table 6 below is a summary of Evoqua's scope of supply for the proposed CoMag system included in this budgetary proposal.

Table 6: Evoqua Scope of Supply.

Item	Quantity	Description
CoMag Components		
Mixer – coagulation tank	1/tank	Pier mounted, vertical shaft

Item	Quantity	Description
		1 HP
Mixer – ballast tank	2/tank	Pier mounted, vertical shaft 0.5 HP
Mixer – polymer tank	2/tank	Pier mounted, vertical shaft 0.5 HP
Clarifier internals	1/clarifier	
Pump – return sludge / waste sludge	1 duty/ 1 standby /train	Horizontal centrifugal 5 HP
Magnetic recovery drum separator	1/train	1 HP
Sludge shear mixer	1/drum	1 HP
Flow control valves	2/train	Motor operated valve (RAS and WAS flow)
Flow meters	2/train	Waste sludge and recycle sludge
Level sensors/switches	1/train	High level switch
Analytical instrumentation	1/train	Turbidity and pH
Control System Hardware		
Control panel	1	Control panel, HMI, PLC, I/O
Services		
Engineering support		Sit visits/design kickoff; basis of design engineer support
Installation oversight, commissioning and training		Up to 8 days
Start-up and performance testing		Up to 12 days

evoqua
WATER TECHNOLOGIES

5 BUDGETARY PRICING

The budgetary price for the Evoqua CoMag system, as defined herein, including process and design engineering, field services, and equipment supply is **$650,000.**

This price makes no provision for taxes, tariffs, duties, permitting fees and other fees and charges that are not made explicit above.

All pricing is quoted at FOB, Factory (full freight allowed). No taxes, regulatory fees or other costs related to the procurement and installation of the system are included.

The initial magnetite charge for the proposed system will require approximately **100** pounds of virgin magnetite at design conditions. Evoqua can provide magnetite at a cost of **$515** per ton plus freight.

The scope of supply and pricing are based on Evoqua standard equipment selection, standard terms of sale and warranty terms as described herein. Any variations from these standards may affect this budgetary quotation. Additionally, please note this budgetary quotation is for review and informational purposes only and does not constitute an offer for acceptance.

Should you have any questions regarding this quotation, or would like to request a firm proposal and order form, please contact the following Evoqua Regional Representative:

Michael Sullivan
David F Sullivan & Assoc.
19 Batchelder Rd., Suite 2B
Seabrook, NH 03874
(508) 878-1016

Appendices

A. Frequently Asked CoMag Questions

B. Typical Drawings

APPENDIX A – FREQUENTLY ASKED QUESTIONS

1. GENERAL QUESTIONS ABOUT MAGNETITE, THE FUNDAMENTAL ELEMENT USED IN COMAG TO INCREASE SETTLING RATES AND RELIABILITY.

Q. What is magnetite?

A. *Magnetite is fully oxidized iron ore (Fe_3O_4). It is completely inert; it cannot rust; it doesn't degrade with time or usage; it has no effect on biological floc; and it is not magnetic itself; i.e., it doesn't stick to metal.*

Q. How does magnetite improve the performance of clarifiers and biological treatment systems?

A. *Magnetite is a very dense material with a specific gravity of 5.2. By comparison the specific gravity of water is 1.0; a chemical hydroxide floc is fractionally over 1.0. By infusing magnetite into a chemical floc, the specific gravity is significantly increased; thereby increasing the settling rate of the floc and gaining consistent control of the sludge blanket in the clarifier and greater stability for the whole system.*

Q. Is magnetite readily available?

A. *Yes, magnetite is mined and processed at multiple sites around the world. In the USA, Evoqua has identified multiple vendors that will provide magnetite to our specifications.*

Q. What is the cost of magnetite?

A. *Magnetite is inexpensive, ranging from $0.20 to $0.50 per pound delivered, depending on the location of the distributor and the facility. Moreover, since the recovery rates of magnetite in CoMag systems are so high, daily consumption is very low; so much so that in assessing the operating cost of a CoMag system, the ongoing cost of magnetite is of no consequence.*

Q. Is the magnetite abrasive? Does magnetite cause excessive wear to pumps?

A. *Unlike micro-sand, a ballast used by our competitors, Evoqua specified magnetite is so fine that it has the consistency of talcum powder. Hence, it is not abrasive and doesn't cause abnormal wear and tear on a treatment systems pumps, mixers, valves and other components. At the seminal CoMag plant in Concord, MA there has been no discernable wear on the plants sludge pumps or mixers after 5.0 years of operation.*

Q. Does magnetite degrade at high temperatures (or low temperatures) or with changes in pH?

A. *Magnetite does not undergo any physical or chemical change in the temperature and pH ranges associated with almost all municipal and industrial wastewater treatment.*

Q. Does magnetite affect pH or the chemical characteristics of the effluent?

A. *No, magnetite is completely inert; has no effect on pH or the chemical characteristics of a system's effluent.*

Q. Does magnetite affect the oxygen content of wastewater?

A. *Since magnetite (Fe_3O_4) is fully oxidized, it does not consume dissolved oxygen in the wastewater.*

Q. How much magnetite is recovered on the magnetic drum and where does the remainder go?

A. *Evoqua has modified the design of conventional magnetic drums to optimize the capture and reuse of magnetite. In CoMag systems, the drums recover in excess of 99.8% of the magnetite in the sludge. Any magnetite not captured by the drum is carried away in the sludge where we have found no effect on downstream sludge management systems or processing.*

Q. What is the impact of magnetite on the effluent; TSS, turbidity, etc.

A. *Less than a half a percent of the magnetite used in CoMag escapes the system; hence, the direct effect on the effluent quality of either system is negligible. It is however, the use of magnetite in Evoqua's CoMag systems that enables both systems to achieve such high levels of contaminant removal. For example, the effluent turbidity from the Concord CoMag system can be easily reduced to levels less than that of bottled drinking water.*

Q. How does magnetite in the effluent effect the performance of a downstream UV disinfection system?

A. *Since very little of the magnetite escapes the system, the direct effect is not discernable. In fact, CoMag as a tertiary polishing system is a UV enabler. The fact that CoMag can perform well with alum coagulants and achieve very high levels of transmissivity, makes it possible to employ less UV treatment (and power)to achieve required levels of pathogen removal. Concord uses only 50% of one of its three banks of UV to meet its permit levels.*

2. QUESTIONS OFTEN ASKED ABOUT THE COMAG PROCESS AND PERFORMANCE:

Q. How does CoMag handle high flows and surges?

A. *CoMag uses automated controls to rapidly respond to flow variations. CoMag is also particularly effective in maintaining high removal levels during surges in solids loading. Unlike other ballasted sedimentation systems, the CoMag process recycles a significant fraction of settled solids* *from its clarifier back to its reaction tanks. The high mass and density of solids in the reaction tanks is many times greater than that of any surge in influent loading. The system is fully capable of managing surges in load with little degradation of performance. The result is superior solids removal, especially compared to those processes that don't incorporate an internal solids recycle.*

Q. Can CoMag equipment be serviced over the 20-year design period?

A. All the components of the CoMag process are readily available in the marketplace. The system employs standard pumps, mixers, piping, valves, clarifier systems, and instruments. The magnetic components have been used in the mining industry since the early 1970s. Spare parts are readily available from multiple sources.

Q. What is the cost to install CoMag including the cost of structures, equipment, connecting piping, peripheral support systems, associated power and instrumentation, etc?

A. The installation costs are low for a CoMag system because of its simplicity, small footprint, and readily available parts. In addition and unlike alternative solutions, CoMag may not need expensive post treatment filters to achieve the required treatment levels of current and expected future permits.

Q. What are the costs of chemicals, additives, power, equipment, and labor associated with the CoMag process.

A. Generally, the operational costs of CoMag are quite low.

Chemical consumption with CoMag is likely to be less than other competitive systems due to the ability of CoMag to achieve required treatment levels with less coagulant and flocculent.

The process provides for a nearly complete recovery and reuse of the magnetic ballast hence the cost is low.

Energy consumption is very low, using gravity to flow through the system with minimal required head. The ballast recovery drum employs permanent magnets and hence consumes no energy other than that required to turn the drum.

The system is fully automated; the need for operator attention is minimal.

Q. Are there major parts that will require replacement?

A. There are no major parts that will require replacement other than the perhaps the pumps and sludge shear mixer, which are expected to have a useful life of 10 years or more. Their replacement is a simple process as they are easily accessible and readily available. None of the parts are hazardous or would require special disposal.

Q. Does CoMag enable the use of alternative chemicals with the same performance?

A. *Yes. CoMag will produce nearly the same contaminant removal levels with alum, ferric chloride, or poly-aluminum chloride (PAC), and other conventional coagulants. The size of the CoMag system is the same for any coagulant, unlike other competitive systems. This gives the flexibility to meet limits with a coagulant chemical that best suits a plant's needs.*

Q. Are CoMag and its operation easily understood and operated?

A. *Yes, CoMag is very operator friendly. The system readily responds to changing influent flows and loads, easily handling excess solids from the secondary clarifiers. It has few parts needing replacement and CoMag requires no sand filters, which can clog and must be backwashed.*

Q. Can the process operate 24 hours with only being manned 8 hours a day?

A. *Yes. The CoMag system has fully automated PLC controls.*

Q. Are the process and its operation safe for operations and/or maintenance personnel?

A. *Yes. CoMag equipment complies with industry standards for safety. It uses chemicals that can be safely handled without additional or specialized training.*

Q. Does the process have operational flexibility such as taking some units out of service on a seasonal basis to save on operational costs?

A. *Yes. CoMag can be designed to provide a high level of redundancy when required and the ability to modify operations to meet effluent requirements*

The CoMag system is designed to treat peak flows and meet the treatment requirements.

Inherent in the operation of CoMag is the ability to manage dosage levels to meet effluent contaminant requirements.

Q. Could the process have a negative effect on downstream unit operations, if needed for higher effluent quality in the future?

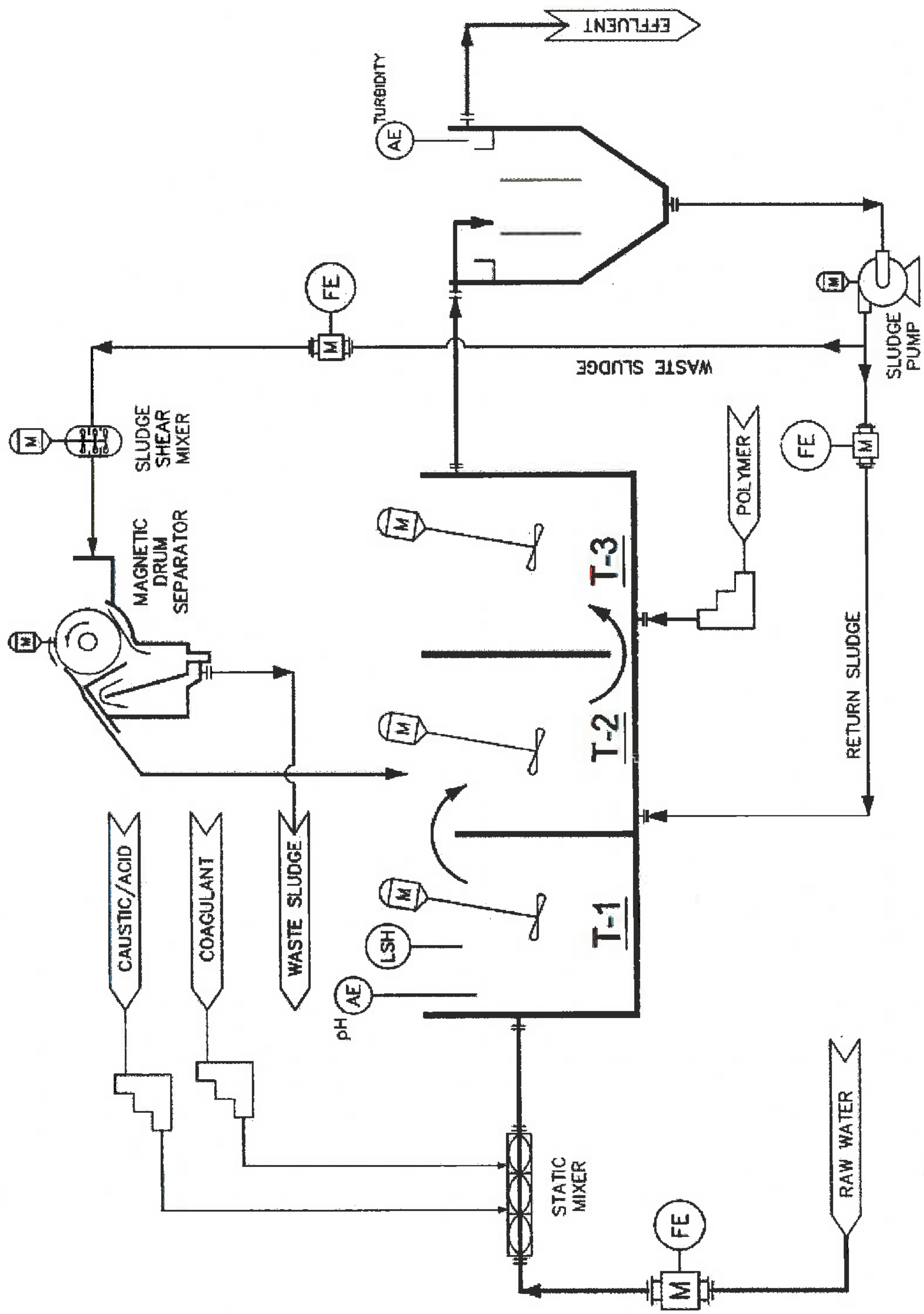
A. *Implementation of CoMag will eliminate the need for downstream filters, thus eliminating the associated capital and O&M costs.*

Q. Does the ballast rust or stick to steel pipe?

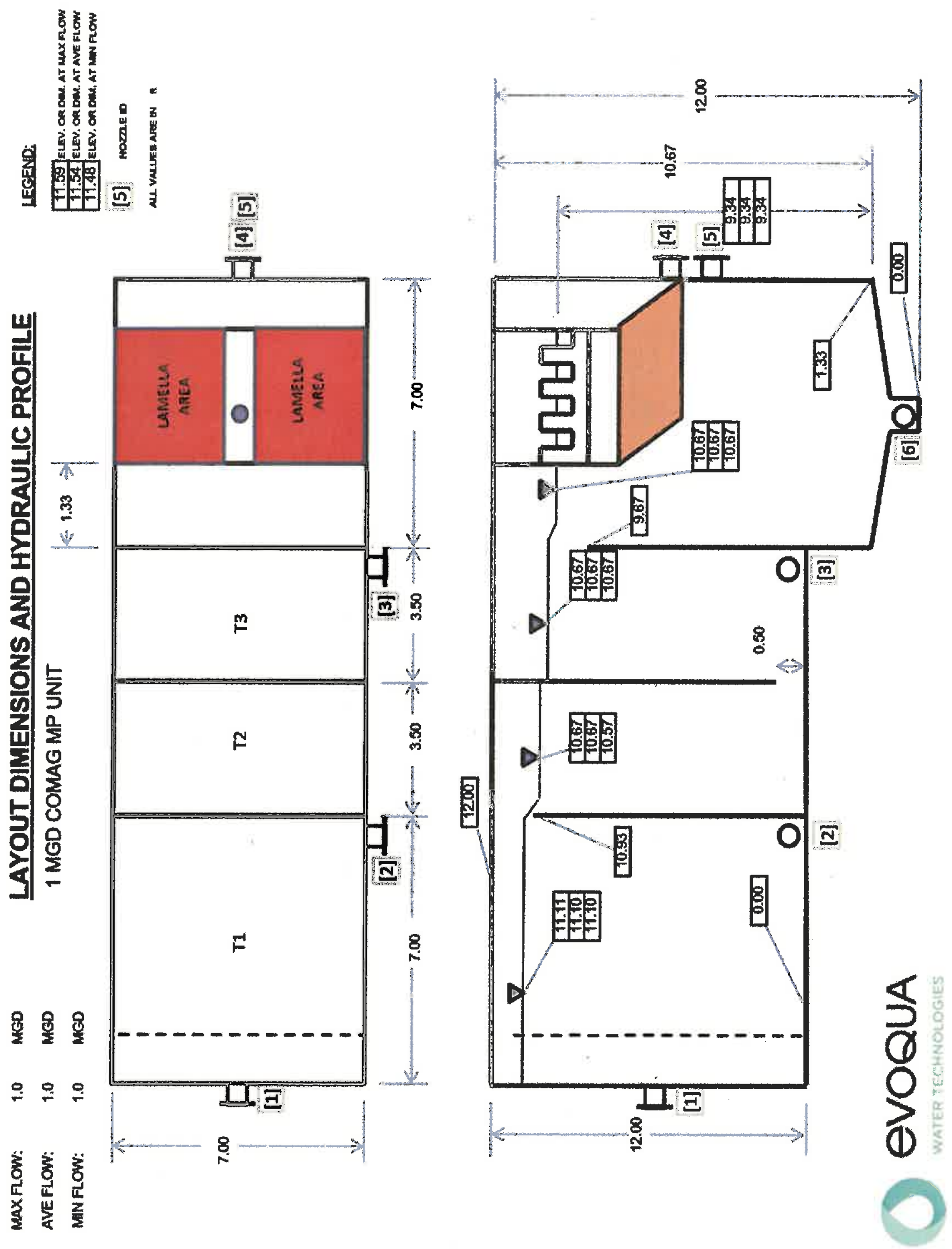
A. *No, the ballast is a type of iron ore that is fully oxidized and does not rust. It is attracted to magnets, but it does not attach itself to steel pipe.*

Appendix B – Typical Drawings

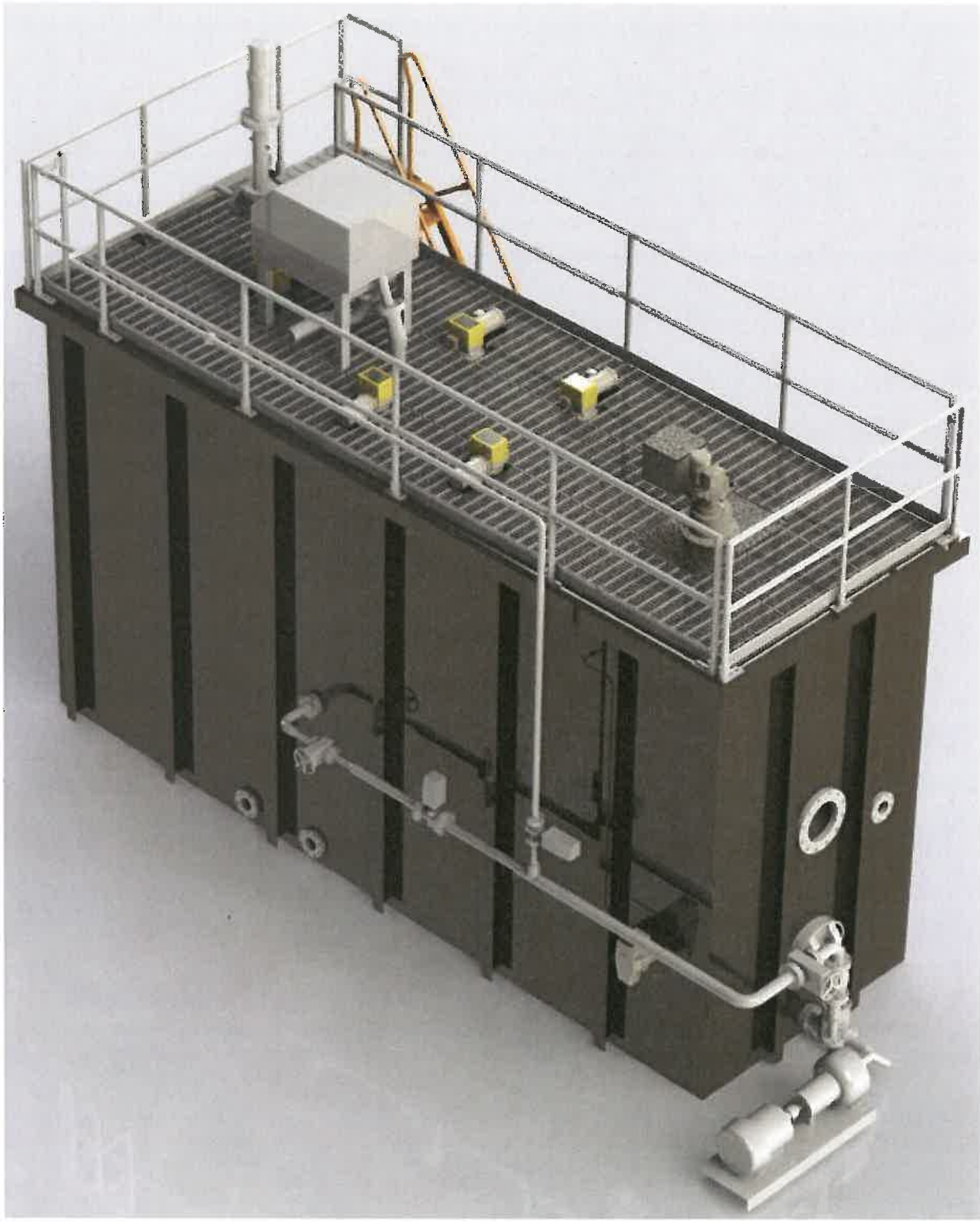
Process Flow Diagram



Tank Layout Diagram



CoMag System Rendering (Fully Assembled)



APPENDIX G

Aqua Aerobics Proposal

PROCESS DESIGN REPORT

AQUA-AEROBIC
SYSTEMS, INC.

HINESBURG, VT

Design#: 142901

Option: Preliminary Design

Designed By: Sophia Bainbridge on Monday, January 18, 2016

The enclosed information is based on preliminary data which we have received from you. There may be factors unknown to us which would alter the enclosed recommendation. These recommendations are based on models and assumptions widely used in the industry. While we attempt to keep these current, Aqua-Aerobic Systems, Inc. assumes no responsibility for their validity or any risks associated with their use. Also, because of the various factors stated above, Aqua-Aerobic Systems, Inc. assumes no responsibility for any liability resulting from any use made by you of the enclosed recommendations.

Design Notes

Pre-SBR

- Neutralization is recommended/required ahead of the SBR if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Coarse solids removal/reduction is recommended prior to the SBR.

- Elevated concentration of Hydrogen Sulfide can be detrimental to both civil and mechanical structures. If anaerobic conditions exist in the collection system, steps should be taken to eliminate Hydrogen Sulfide prior to the treatment system.

SBR

- The maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

- The decanter performance is based upon a free-air discharge following the valve and immediately adjacent to the basin. Actual decanter performance depends upon the complete installation including specific liquid and piping elevations and any associated field piping losses to the final point of discharge. Modification of the high water level, low water level, centerline of discharge, and / or cycle structure may be required to achieve discharge of full batch volume based on actual site installation specifics.

Aeration

- The aeration system has been designed to provide 1.25 lbs. O2/lb. BOD5 applied and 4.6 lbs. O2/lb. TKN applied at the design average loading conditions.

Process/Site

- It is assumed that the peak design flow equals the average design flow.

- The anticipated effluent NH3-N requirement is predicated upon an influent waste temperature of 10° C or greater. While lower temperatures may be acceptable for a short-term duration, nitrification below 10° C can be unpredictable, requiring special operator attention.

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- To achieve an effluent monthly average total phosphorus limit, the biological process, chemical feed systems, and Cloth Media Filters need to be designed to facilitate optimum performance.

- A minimum of twelve (12) daily composite samples per month (both influent and effluent) shall be obtained for total phosphorus analysis.

- Influent to the biological system is a typical municipal wastewater application with a TP range of 6–8 mg/l. Influent TP shall be either in a particle associated form or in a reactive soluble phosphate form or in a soluble form that can be converted to reactive phosphorus in the biological system. Soluble hydrolyzable and organic phosphates are not removable by chemical precipitation with metal salts. A water quality analysis is required to determine the phosphorus speciation with respect to soluble and insoluble reactive, acid hydrolyzable and total phosphorus at the system influent, point(s) of chemical addition, and final effluent.

- Chemical feed lines (i.e. metal salts) shall be furnished to each reactor, aerobic digester and dewatering supernatant streams as necessary. Metal salts shall be added to each reactor during the React phase of the cycle.

- Chemical addition (i.e. metal salts, polymer) shall be furnished prior to the filter. Adequate rapid mixing must be provided as part of the chemical feed system. The chemical dosage should be flow-paced and controlled to avoid overdosing. Jar testing with various metal salts and polymers is recommended to determine the most effective metal salt and polymer as well as the optimum dosages of each, and to estimate the degree of phosphorus removal that can be achieved. In addition, a pilot study may be required to verify the actual performance capability.

- A flocculation tank with a minimum of 5-minute HRT at the maximum daily flow shall be furnished after chemical addition and prior to the filter.

- pH monitoring and control in a range of 6.8-7.2 of the upstream biological reactor is required when adding metal salts.

- The cloth media filter will only remove TP that is associated with the TSS removed by the filter. Solids include both biological and chemical solids. Since only insoluble, particle-associated phosphorous is capable of being removed by filtration with tertiary filtration technology, phosphorous speciation shall be provided by the owner to substantiate the concentrations of soluble and insoluble phosphorous in the filter influent. If the proportions of soluble (unfilterable) and insoluble phosphorous are such that removal to achieve the desired effluent limit is not practical, the owner will provide for proper conditioning of the wastewater, upstream of the filter system, to allow for the required removal.

Filtration

- The anticipated filtered effluent quality is based on the filter influent conditions as shown under "Design Parameters" of this Process Design Report. In addition, the filter influent should be free of algae and other solids that are not filterable through a nominal 10 micron pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- For this application, pile filter cloth is recommended.

- Redundancy has not been considered in this design.

Equipment

- The basin dimensions reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square, rectangular or sloped with construction materials including concrete, steel or earthen.

- Rectangular or sloped basin construction with length to width ratios greater than 1.5:1 may require alterations in the equipment recommendation.

- The basins are not included and shall be provided by others.

- Influent is assumed to enter the reactor above the waterline, located appropriately to avoid proximity to the decanter, splashing or direct discharge in the immediate vicinity of other equipment.

- If the influent is to be located submerged below the waterline, adequate hydraulic capacity shall be made in the headworks to prevent backflow from one reactor to the other during transition of influent.

- A minimum freeboard of 2.0 ft. is recommended for diffused aeration.

- Equipment selection is based upon Aqua Aerobic Systems' standard materials of construction and electrical components.

- Aqua-Aerobic Systems, Inc. is familiar with various "Buy American" Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project's "Buy American" provisions.

- Scope of supply includes freight, installation supervision and start-up services.

AquaSBR - Sequencing Batch Reactor - Design Summary

DESIGN INFLUENT CONDITIONS

Avg. Design Flow	= 0.45 MGD	= 1703 m3/day
Max Design Flow	= 0.45 MGD	= 1703 m3/day

DESIGN PARAMETERS

	Influent	mg/l	Effluent (After Filtration) Required	<= mg/l	Anticipated	<= mg/l
Bio/Chem Oxygen Demand:	BOD5	312	BOD5	30	BOD5	30
Total Suspended Solids:	TSS	287	TSSa	30	TSSa	30
Phosphorus:	Total P	8	--	0.11	--	0.11

SITE CONDITIONS

	Maximum		Minimum		Design		Elevation (MSL)
Ambient Air Temperatures:	85 F	29.4 C	30 F	-1.1 C	85 F	29.4 C	500 ft
Influent Waste Temperatures:	68 F	20.0 C	50 F	10.0 C	68 F	20.0 C	152.4 m

SBR BASIN DESIGN VALUES

			Water Depth			Basin Vol./Basin		
No./Basin Geometry:	= 2 Rectangular Basin(s)		Min	= 14.3 ft	= (4.4 m)	Min	= 0.120 MG	= (453.1 m³)
Freeboard:	= 2.0 ft	= (0.6 m)	Avg	= 21.0 ft	= (6.4 m)	Avg	= 0.176 MG	= (666.0 m³)
Length of Basin:	= 40.0 ft	= (12.2 m)	Max	= 21.0 ft	= (6.4 m)	Max	= 0.176 MG	= (666.0 m³)
Width of Basin:	= 28.0 ft	= (8.5 m)						

Number of Cycles:	= 4 per Day/Basin (advances cycles beyond MDF)	
Cycle Duration:	= 6.0 Hours/Cycle	
Food/Mass (F/M) ratio:	= 0.130 lbs. BOD5/lb. MLSS-Day	
MLSS Concentration:	= 4500 mg/l @ Min. Water Depth	
Hydraulic Retention Time:	= 0.782 Days @ Avg. Water Depth	
Solids Retention Time:	= 9.2 Days	
Est. Net Sludge Yield:	= 0.734 lbs. WAS/lb. BOD5	
Est. Dry Solids Produced:	= 860.0 lbs. WAS/Day	= (390.1 kg/Day)
Est. Solids Flow Rate:	= 150 GPM (10311 GAL/Day)	= (39.0 m³/Day)
Decant Flow Rate @ MDF:	= 938.0 GPM (as avg. from high to low water level)	= (59.2 l/sec)
LWL to CenterLine Discharge:	= 1.0 ft	= (0.3 m)
Lbs. O2/lb. BOD5	= 1.25	
Lbs. O2/lb. TKN	= 4.60	
Actual Oxygen Required:	= 1464 lbs./Day	= (663.9 kg/Day)
Air Flowrate/Basin:	= 534 SCFM	= (15.1 Sm³/min)
Max. Discharge Pressure:	= 9.7 PSIG	= (67 KPA)
Avg. Power Required:	= 461.7 KW-Hrs/Day	

Post-Equalization - Design Summary

POST-SBR EQUALIZATION DESIGN PARAMETERS

Avg. Daily Flow (ADF):	= 0.45 MGD	= (1,703 m^3/day)
Max. Daily Flow (MDF):	= 0.45 MGD	= (1,703 m^3/day)
Decant Flow Rate from (Qd):	= 938 gpm	= (3.6 m^3M)
Decant Duration (Td):	= 60 min	
Number Decants/Day:	= 8	
Time Between Start of Decants:	= 180 min	

POST-SBR EQUALIZATION VOLUME DETERMINATION

The volume required for equalization/storage shall be provided between the high and the low water levels of the basin(s). This Storage Volume (Vs) has been determined by the following:

Vs = [(Qd -(MDF x 694.4)] x Td = 37,530 gal = (5,017.4 ft^3) = (142.1 m^3)

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

Based upon liquid level inputs from each SBR reactor prior to decant, the rate of discharge from the Post-SBR Equalization basin shall be pre-determined to establish the proper number of pumps to be operated (or the correct valve position in the case of gravity flow). Level indication in the Post-SBR Equalization basin(s) shall override equipment operation.

POST-SBR EQUALIZATION BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)				
Length of Basin:	= 28.0 ft	= (8.5 m)			
Width of Basin:	= 19.0 ft	= (5.8 m)			
Min. Water Depth:	= 1.5 ft	= (0.5 m)	**Min. Basin Vol. Basin:**	= 5,969.0 gal	= (22.6 m^3)
Max. Water Depth:	= 10.9 ft	= (3.3 m)	**Max. Basin Vol. Basin:**	= 43,499.0 gal	= (164.7 m^3)

POST-SBR EQUALIZATION EQUIPMENT CRITERIA

Mixing Energy with Diffusers:	= 15 SCFM/1000 ft^3	
SCFM Required to Mix:	= 87 SCFM/basin	= (148 Nm^3/hr/basin)
Max. Discharge Pressure:	= 5.3 PSIG	= (36.59 KPA)
Max. Flow Rate Required Basin:	= 313 gpm	= (1.183 m^3/min)
Avg. Power Required:	= 67.3 kW-hr/day	

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment:	SBR		
Avg. Design Flow	= 0.45 MGD	= 312.50 gpm	= 1703 m³/day
Max Design Flow	= 0.45 MGD	= 312.5 gpm	= 1703 m³/day

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended	= 1
Number Of Disks Per Unit	= 10
Total Number Of Disks Recommended	= 10
Total Filter Area Provided	= 108.0 ft² = (10.03 m²)
Filter Model Recommended	= AquaDisk Package: Model ADFSP-11-10E-PC
Filter Media Cloth Type	= OptiFiber PES-14

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a hopper-bottom and solids removal manifold system.

Average Flow Conditions:

Average Hydraulic Loading = Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
= 312.5 / 108 ft²
= 2.89 gpm/ft² (1.97 l/s/m²) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading = Max. Design Flow (gpm) / Recommended Filter Area (ft²)
= 312.5 / 108 ft²
= 2.89 gpm/ft² (1.97 l/s/m²) at Max. Flow

Solids Loading:

Solids Loading Rate = (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft²)
= 56.3 lbs/day / 108 ft²
= 0.52 lbs. TSS /day/ft² (2.54 kg. TSS/day/m²)

AquaSBR

Influent Valves

2 Influent Valve(s) will be provided as follows:

- 6 inch electrically operated plug valve(s).

Mixers

2 AquaDDM Direct Drive Mixer(s) will be provided as follows:

- 5 HP Aqua-Aerobic Systems Endura Series Model FSS DDM Mixer(s).

Mixer Mooring

2 Mixer pivotal mooring assembly(ies) consisting of:

- 304 stainless steel pivotal mooring arm(s).
- #12 AWG-four conductor electrical service cable(s).
- Electrical cable strain relief grip(s), 2 eye, wire mesh.

2 Mixer De-Watering Support(s) will be provided as follows:

- Galvanized steel dewatering support post(s).
- Galvanized steel support angle(s).
- 304 stainless steel anchors.

Decanters

2 Decanter assembly(ies) consisting of:

- 6x4 Aqua-Aerobics decanter(s) with fiberglass float, 304 stainless steel weir, galvanized restrained mooring frame, and painted steel power section with #14-10 conductor power cable wired into a NEMA 4X stainless steel junction box with terminal strips for the single phase, 60 hertz actuator and limit switches.
- 8 inch diameter decant hose assembly.
- 4" schedule 40 galvanized steel mooring post.
- 8 inch electrically operated butterfly valve(s) with actuator.

Transfer Pumps/Valves

2 Submersible Pump Assembly(ies) consisting of the following items:

- 3 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- Manual plug valve(s).
- 3 inch diameter swing check valve.
- Galvanized steel slide rail assembly(ies).
- 304 stainless steel intermediate support(s).

Retrievable Coarse Bubble Diffusers

4 Retrievable Coarse Bubble 10 Tube Diffuser Assembly(ies) consisting of:

- 316 L stainless steel wide band coarse bubble diffusers with Schedule 80 3/4" NPT male pipe thread connection with integral hex head nut.
- Galvanized manifold assembly.
- Galvanized vertical support beam.
- Galvanized upper vertical beam and pulley assembly with manual winch.
- Galvanized top support bracket.
- 3" EPDM flexible air line with ny-glass quick disconnect end fittings.
- Galvanized threaded flange.
- 3" manual isolation butterfly valve with cast iron body, EPDM seat, aluminum bronze disk and one-piece steel shaft.

- Ny-glass quick disconnect cam lock adapter.
- 304 stainless steel adhesive anchors.

Positive Displacement Blowers

3 Positive Displacement Blower Package(s), with each package consisting of:

- Sutorbilt 6M Positive Displacement Blower Package with common base, V-belt drive, enclosed drive guard, pressure gauge, pressure relief valve, and vibration pads.
- 304 stainless steel anchors.
- 25 HP motor with slide base.
- Inlet filter and inlet silencer.
- Discharge silencer, check valve, manual butterfly isolation valve, and flexible discharge connector.

Air Valves

2 Air Control Valve(s) will be provided as follows:

- 6 inch electrically operated butterfly valve(s) with actuator.

Level Sensor Assemblies

2 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).
- 304 stainless steel anchors.

2 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- 304 stainless steel anchors.

Instrumentation

2 Dissolved Oxygen Assembly(ies) consisting of:

- Thermo Fisher RDO dissolved oxygen probe with electric cable. Probe includes stainless steel stationary bracket and retrievable pole probe mounting assembly. One (1) probe per basin.
- Thermo Fisher AV38 controller and display module(s).

AquaSBR: Post-Equalization

Transfer Pumps/Valves

3 Submersible Pump Assembly(ies) consisting of the following items:

- 3 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- Manual plug valve(s).
- 3 inch diameter swing check valve.
- Galvanized steel slide rail assembly(ies).

Fixed Coarse Bubble Diffusers

1 Aqua-Aerobic's Fixed Coarse Bubble Diffuser System(s) consisting of the following components:

- PVC diffuser(s).
- Schedule 40 galvanized steel riser pipe(s).
- Schedule 40 PVC manifold piping.
- 304 stainless steel anchors.

Positive Displacement Blowers

2 Positive Displacement Blower Package(s), with each package consisting of:

- Sutorbilt 3M Positive Displacement Blower Package with common base, V-belt drive, enclosed drive guard, pressure gauge, pressure relief valve, and vibration pads.
- 304 stainless steel anchors.

- 5 HP motor with slide base.
- Inlet filter and inlet silencer.
- Discharge silencer, check valve, manual butterfly isolation valve, and flexible discharge connector.

Level Sensor Assemblies

1 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).
- 304 stainless steel anchors.

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- 304 stainless steel anchors.

Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Allen Bradley 1769-L30ER Compactlogix integral programmable controller.
- Operator interface(s).
- Remote Access Ethernet Modem.

Cloth Media Filters

AquaDisk Tanks/Basins

1 AquaDisk Model # ADFSP-11x10E-PC Package Filter Painted Steel Tank(s) consisting of:

- 10 disk tank(s) will be painted steel, estimated dry weight is 4,850 lbs., and estimated operating weight is 14,750 lbs. Each tank will include an integral solids waste collection manifold.
The tank finish will be:
Interior: Near white sandblast (SSPC-SP10), painted with Tnemec N69 polyamide epoxy (color safety blue) 2 coats 4-6 mils each for 8-12 mils DFT.
Exterior: Commercial sandblast (SSPC-SP6), painted Tnemec N69 Hi-Build Epoxoline II (color safety blue) 2 coats 3-4 mils each, 1 coat Tnemec 1075 Endura-Shield II, 2-3 mils for 8-11 mils DFT.
- 2" ball valve(s).

AquaDisk Centertube Assemblies

1 Cloth will have the following feature:

- Cloth will be OptiFiber PES-14.

1 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Centertube bearing kit(s).
- Effluent centertube lip seal.
- Pile cloth media and non-corrosive support frame assemblies.
- 304 Stainless steel frame top plate(s),
- Media sealing gaskets.
- Disk segment 304 stainless steel support rods.

AquaDisk Drive Assemblies

1 Drive System(s) consisting of:

- Gearbox with motor.
- Drive sprocket(s).
- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

1 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 1 1/2" flexible hose.
- Stainless steel backwash shoe springs.
- Hose clamps.

1 Backwash/Solids Waste Pump(s) consisting of:

- Backwash/waste pump(s).
- 0 to 15 psi pressure gauge(s).
- 0 to 30 inches mercury vacuum gauge(s).
- Throttling gate valve(s).
- 2" bronze 3 way ball valve(s).

AquaDisk Instrumentation

1 Pressure Transmitter(s) consisting of:

- Level transmitter(s).

1 Vacuum Transmitter(s) consisting of:

- Vacuum transmitter(s).

1 Float Switch(es) consisting of:

- Float switch(es).
- Float switch support bracket(s).

AquaDisk Valves

1 Solids Waste Valve(s) consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

1 Set(s) of Backwash Valves consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

AquaDisk Controls w/Starters

1 Control Panel(s) consisting of:

- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s).
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).

- MicroLogix 1400 PLC(s).
- Ethernet switch(es).
- Operator interface(s).
- Power supply(ies).
- Motor starter(s).
- Terminal blocks.
- UL label(s).

1 Conduit Installation(s) consisting of:

- PVC conduit and fittings.